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ANNALS *of* SURGERY

VOL. LXX AUGUST, 1919 No. 2

EXPERIMENTAL HYDROCEPHALUS*

BY WALTER E. DANDY, M.D.

OF BALTIMORE, MD.

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THE production of all types of hydrocephalus by precise experimental methods finally lifts the idiopathic veil and reveals hydrocephalus as a disease with a clearly defined etiology and pathology. The first evidence that hydrocephalus could be experimentally produced was incorporated in an article with Blackfan in 1913.[1] It was demonstrated that when a tiny obstructing body was introduced into the aqueduct of Sylvius of a dog, all the cerebral ventricles proximal to the occlusion became dilated; distally, the size of the fourth ventricle was not changed.

The following year, Thomas [2] published additional experimental evidence that hydrocephalus was caused by obstruction. Following the injection of aleuronat granules into the lateral ventricles, the iter became plugged; organization of the granules resulted in total occlusion of the opening and hydrocephalus followed.

As early as the middle of the eighteenth century, Haller, Brunner and Littré looked upon an obstruction to the outflow of the ventricular contents through the pituitary body as the cause of hydrocephalus. Such a theory of obstruction can only be regarded as fanciful, since vapor and not fluid was at that time regarded as the normal content of the ventricles; the pituitary body was erroneously regarded as the main avenue of escape for the vapor in the ventricles.

Magendie (1825) first described an anatomical obstruction at the base of the brain in several cases of hydrocephalus, but he was not entirely convinced that the obstruction was the cause, because he regarded the pia as the source of all cerebrospinal fluid. Reasoning from this viewpoint, he

* Read by title before the American Surgical Association, June 18, 1919.

† These studies have been conducted in the laboratories of Professor Halsted. His suggestions have been invaluable in the development of many new problems in a virgin experimental field. The success of many of the crucial experiments is in large part due to consultations with him.

[1] Dandy, W. E., and Blackfan, K. D.: Internal Hydrocephalus. An Experimental, Clinical and Pathological Study. J. Am. M. Assn., 1913, lxi, 2216. Also Am. J. Dis. Child., 1914, viii, 406; Am. J. Dis. Child., 1917, xiv, 424; Beitr. z. klin. Chir., 1914, xciii, 392.

[2] Thomas, W. T.: Experimental Hydrocephalus. J. Exper. Med., 1914, xix, 106.

expected an obstruction to cause dilation of the ventricles posterior rather than anterior to the obstruction. Throughout his publications he was much perplexed by his inability to correlate these pathological findings with his physiological conceptions. He never suspected the choroid plexus as the organ of secretion of the cerebrospinal fluid. The findings, therefore, were inconclusive. Despite his mistaken interpretations, the cases stand as probably the first in which a mechanical obstruction was described and considered to have a bearing on the disease.

Two additional discoveries of the greatest importance were made by Magendie, without which any consideration of the etiology of hydrocephalus would still be useless. He first established the fact that fluid and not air or vapor fills the ventricles and the subarachnoid space in the living; and he discovered the foramen of Magendie, an opening which establishes communication between the ventricular system and the subarachnoid space.

Hilton (1860) did a great deal more to confirm the view that obstruction was the cause of hydrocephalus. He accurately described and made drawings of obstructions in three cases of hydrocephalus; in one a stenosis was in the aqueduct of Sylvius, and in two cases the foramen of Magendie was closed by a scar. In each, hydrocephalus resulted proximal to the obstruction. Numerous examples of obstruction have since been added, but with little additional influence in overcoming a very strong prejudice against the acceptance of the obstructive theory of hydrocephalus.

Opposed to the obstruction theory was the impressive argument that in most cases of hydrocephalus there was no obstruction, and even no cause of any kind could be found. Those who held this negative opinion looked upon obstruction in the remaining cases as purely incidental and in no way etiological; all cases of hydrocephalus were considered idiopathic.

A third school conceived two entirely different types of hydrocephalus: (1) in which an obstruction produced the disease, and (2) in which no cause could be found. The second type they regarded as idiopathic.

The existence of the foramen of Magendie is even now disputed by eminent authorities. Magendie himself admitted, as is now well recognized, that his foramen is not present in dogs and other animals. Why then should it be significant for man? Many still consider this foramen an artefact, as other foramina which have been described have proved to be.

In 1855 Luschka made a discovery which clarifies much of the earlier confusion and makes a theory of obstruction tenable. He discovered two additional openings between the fourth ventricle and the subarachnoid space, making with the foramen of Magendie three in all. These openings, now known as the foramina of Luschka, are also present in all animals; their presence makes it clear why the foramen of Magendie may be absent without hydrocephalus.

But the knowledge of the anatomy of the cerebrospinal spaces and the circulation of the cerebrospinal fluid in these spaces has been very vague. If the fundamental facts are so uncertain, any discussion of the etiology

of the disease must be fruitless. The experiments here presented will clear any uncertainty about the grosser anatomy of the cerebrospinal spaces as well as the normal circulation of the cerebrospinal fluid and the results following the interference with the normal pathways for this circulation.

A very simple experiment will demonstrate the existence of a communication between the ventricles and the subarachnoid space. If phenolsulphonaphthalein or any other inert colored solution is injected into a lateral ventricle it will quickly appear in the spinal fluid removed by lumbar puncture. The location of the communication can be demonstrated by the exclusion of the third and both lateral ventricles, thus limiting the communication to the fourth ventricle. If the aqueduct of Sylvius is occluded experimentally or if, in a patient, it is occluded by any pathological process, the colored solution will not appear in the spinal fluid following an intraventricular injection. This limits the location of the communication to the fourth ventricle. This communication is by the foramina of Luschka and Magendie, can be demonstrated in any brain at necropsy. At any cerebellar operation the foramen of Magendie can easily be seen. So necessary are these openings that when all are absent, as indicated by the phenolsulphonaphthalein test, an internal hydrocephalus invariably must result. The presence of a communication can also be demonstrated by the introduction of air into the lateral ventricle. The air will pass externally and appear in the cisternæ and the sulci over the cerebral hemispheres. The air can be photographed in the X-ray,[3] and it can even be seen passing through the foramen of Magendie into the cisterna magna if one makes a fluoroscopic examination.[4] By these simple tests the possibility of producing an artefact is out of question. The remaining anatomical and physiological facts will be deduced from the succeeding experiments.

HYDROCEPHALUS PRODUCED BY PLACING AN OBSTRUCTION IN THE AQUEDUCT OF SYLVIUS

These experiments were conducted on dogs, under ether anæsthesia. The midportion of the squamous occipital bone, including the posterior margin of the foramen magnum, was removed with rongeurs and the dura opened in a stellate fashion. By gently elevating the cerebellum, the roof of the fourth ventricle was exposed, perforated, and a tiny piece of cotton cautiously pushed forward on the point of a fine graduated carrier. It was passed over the medulla and pons until it glided into the aqueduct of Sylvius, where it was deposited by withdrawal of the carrier. An improved technic of this procedure consists in inclosing the cotton in an oiled gelatin capsule, which soon dissolves in the cerebrospinal fluid (Fig. 1). The aqueduct of Sylvius is fairly easily recognized by the sense of touch imparted to the

[3] Dandy, W. E.: Ventriculography Following the Injection of Air into the Cerebral Ventricles. ANNALS OF SURGERY, July, 1918.

[4] Dandy, W. E.: Fluoroscopy of the Cerebral Ventricles. Bull. Johns Hopkins Hosp., February, 1919.

finger which is directing the entry of the obstruction. The constriction at the terminus of the funnel-like approach from the wide fourth ventricle denotes the entrance to the narrow aqueduct of Sylvius. The iter is, moreover, at a constant measured distance from the posterior border of the cerebellum. If the head is not held in a strictly median position, it is easily possible to make a false passage into the contiguous soft brain tissue, with permanent injury to the pyramidal tract and the nuclei of the cranial nerves.

By producing hydrocephalus with a tiny obstruction in the aqueduct of Sylvius, the etiological rôle of an occlusion is absolutely established. Being a single precise process and involving no neighboring structures, other possible explanations of the resultant hydrocephalus are precluded. When an obstruction is present in any part of the ventricular system, the ventricles always dilate anterior to the occlusion. Following occlusion of the aqueduct of Sylvius, therefore, the third ventricle and both lateral ventricles become distended. The size of the fourth ventricle remains unchanged.

Fig. 2 shows sections of dog's brain one month after the obstruction was introduced. Doubtless, for some time after the cotton was placed in the iter, there was only a partial occlusion, which became complete with organization of the foreign body. The animals become lethargic and there is intermittent vomiting. Ventricular dilatation is accompanied by a corresponding degree of cerebral destruction. The experiments were all performed on dogs after union of the sutures of the skull, so that enlargement of the head could not occur. In animals operated on at birth or soon thereafter, the characteristic hydrocephalic enlargement of the head will necessarily be an outstanding feature which cannot be duplicated when the animal is older.

From this series of experiments we have absolute evidence, (1) that *cerebrospinal fluid forms in the cerebral ventricles;* (2) that *absorption of fluid in the ventricles is at least less than the production;* (3) that *the aqueduct of Sylvius is a necessary outlet from the third and both lateral ventricles;* and (4) that *there are no collateral channels which assume the function of the iter when it is occluded.*[5]

UNILATERAL HYDROCEPHALUS PRODUCED BY OCCLUDING ONE FORAMEN OF MONRO

Since the third and both lateral ventricles distend following occlusion of the aqueduct of Sylvius, it is reasonable to expect that an obstruction at one foramen of Monro will produce dilatation of the corresponding lateral ventricle; that is, a unilateral hydrocephalus.

Spiller[6] has published a case of unilateral hydrocephalus with occlusion of one foramen of Monro. The occlusion of the foramen was due to a cica-

[5] For the data concerning the place and manner of formation and absorption of cerebrospinal fluid, the reader is referred to the article previously cited in the American Journal of the Diseases of Children.

[6] Spiller, W. G.: Two Cases of Partial Internal Hydrocephalus from Closure of the Interventricular Passages. Am. J. M. Sc., 1902, p. 44. Also J. Am. M. Assn., 1907, xlviii.

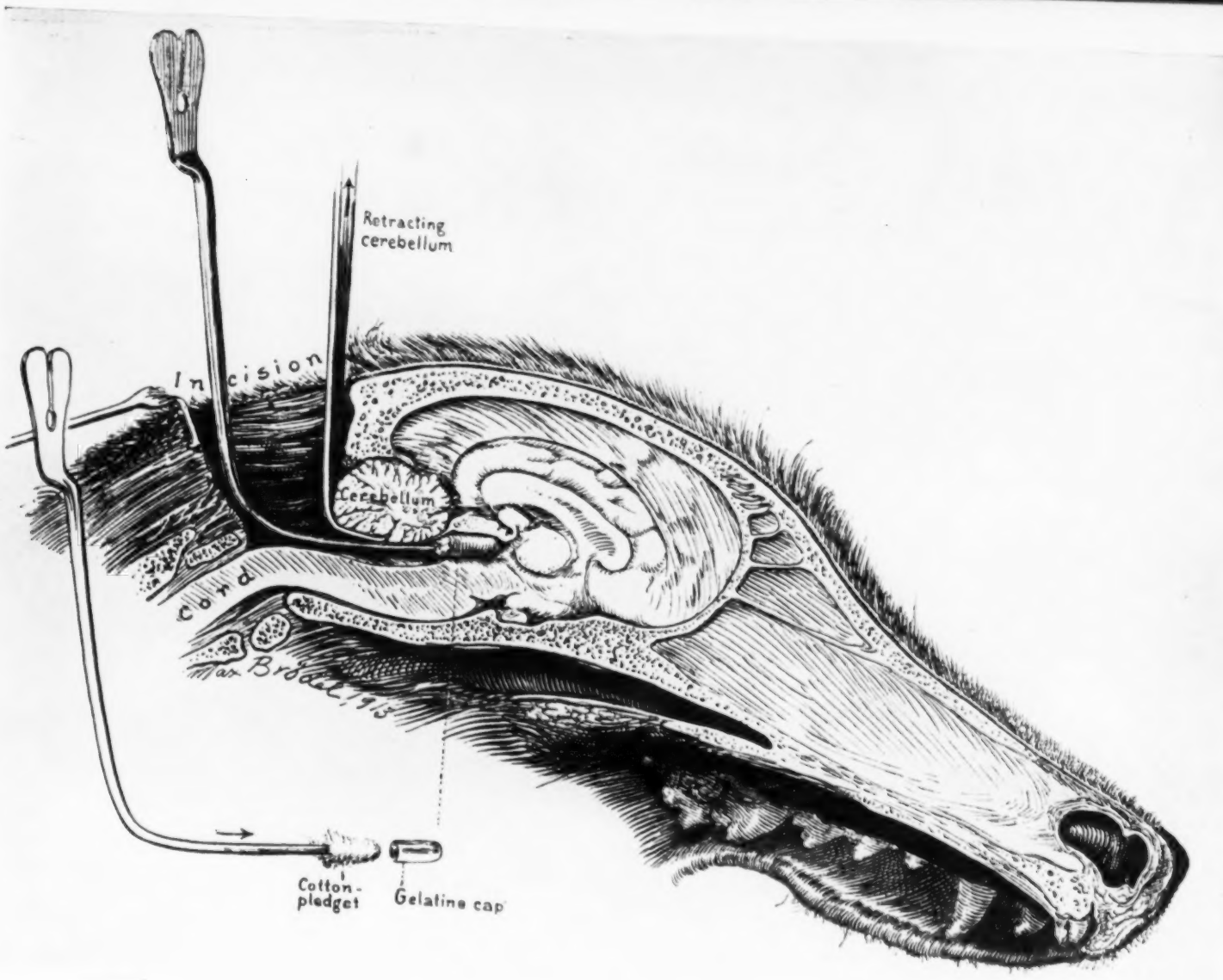


FIG. 1.—Mid-sagittal view of a dog's head to illustrate the method of procedure in occluding the aqueduct of Sylvius. By this method hydrocephalus results, involving the third and both lateral ventricles.

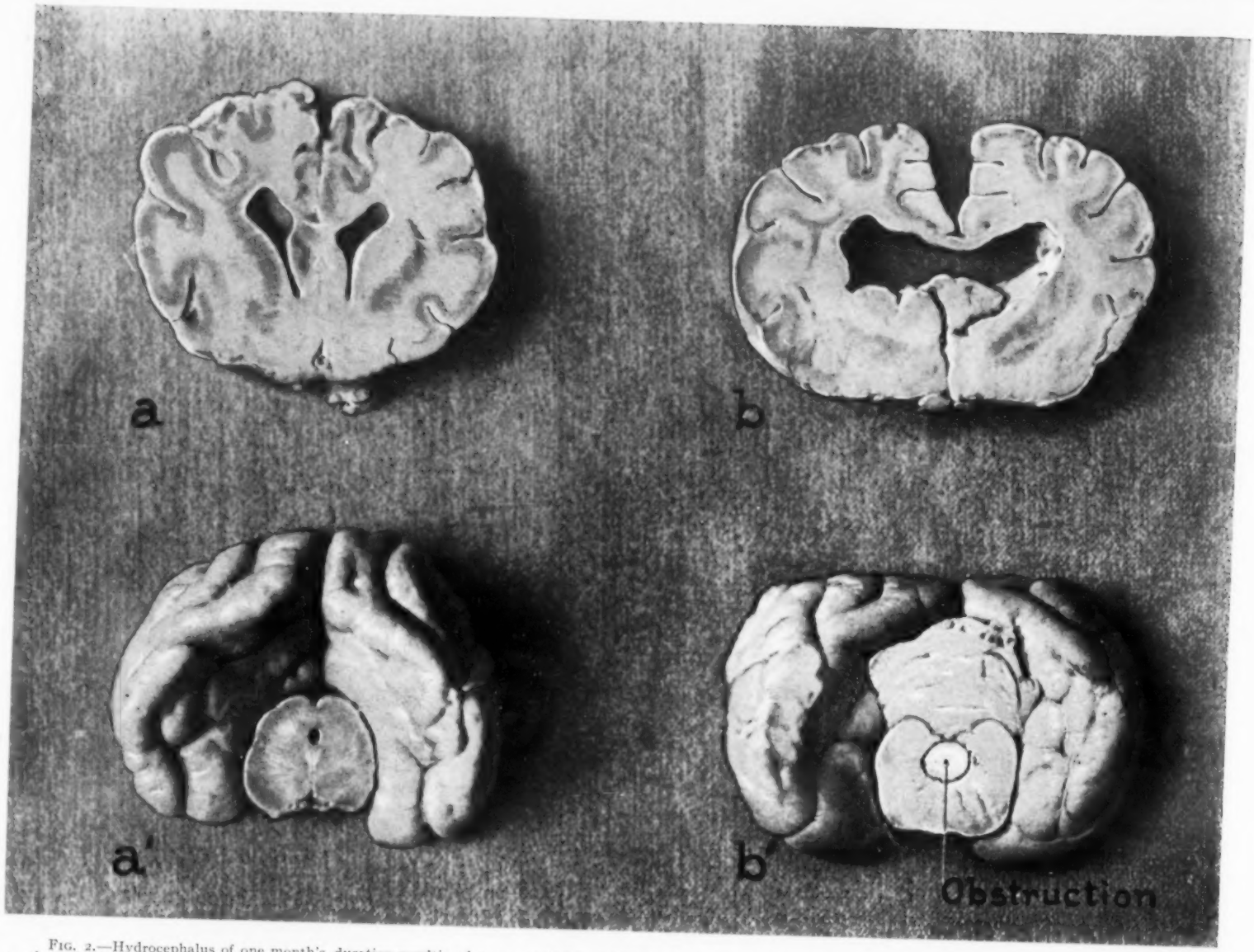


FIG. 2.—Hydrocephalus of one month's duration resulting from an occlusion placed in the aqueduct of Sylvius (*b* and *b'*), as demonstrated in FIG. 1. *a* and *a'* are sections of a normal dog's brain at levels corresponding to *b* and *b'*. Note the fusion of both lateral ventricles (in *b*) following atrophy of the septum lucidum. The obstruction is shown in the iter (*b'*).

FIG. 3.—To demonstrate the method of introducing a piece of fascia into the foramen of Monro of a dog's brain. A transcortical incision into the ventricle at this point also permits complete choroid plexectomy of one lateral ventricle. Being well posterior, injury to the pyramidal tract is also avoided.

FIG. 4.—Lateral view of a dog's brain to show method of occluding the foramen of Monro. The outline of the lateral ventricle is shown by a dotted line.

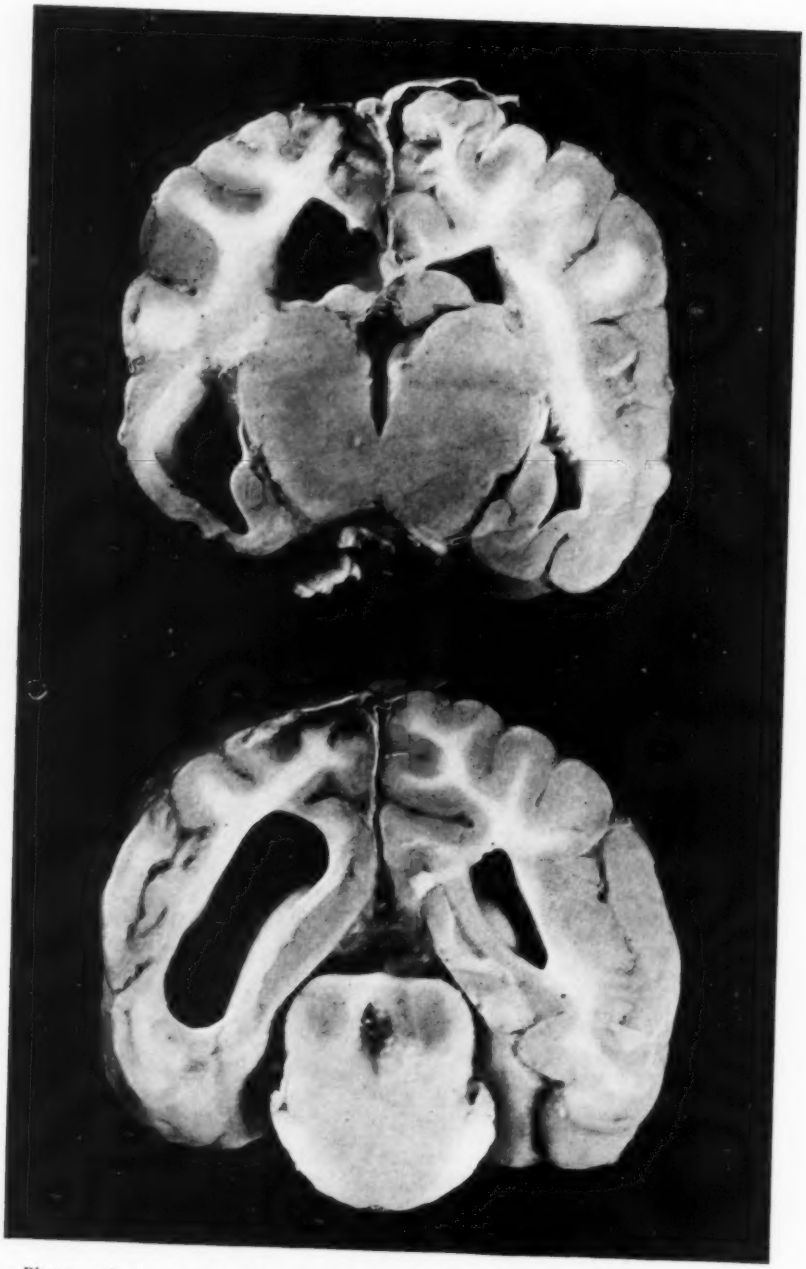


FIG. 5.—Photograph of sections of a dog's brain in which a unilateral hydrocephalus has followed occlusion of the left foramen of Monro. The right ventricle is normal.

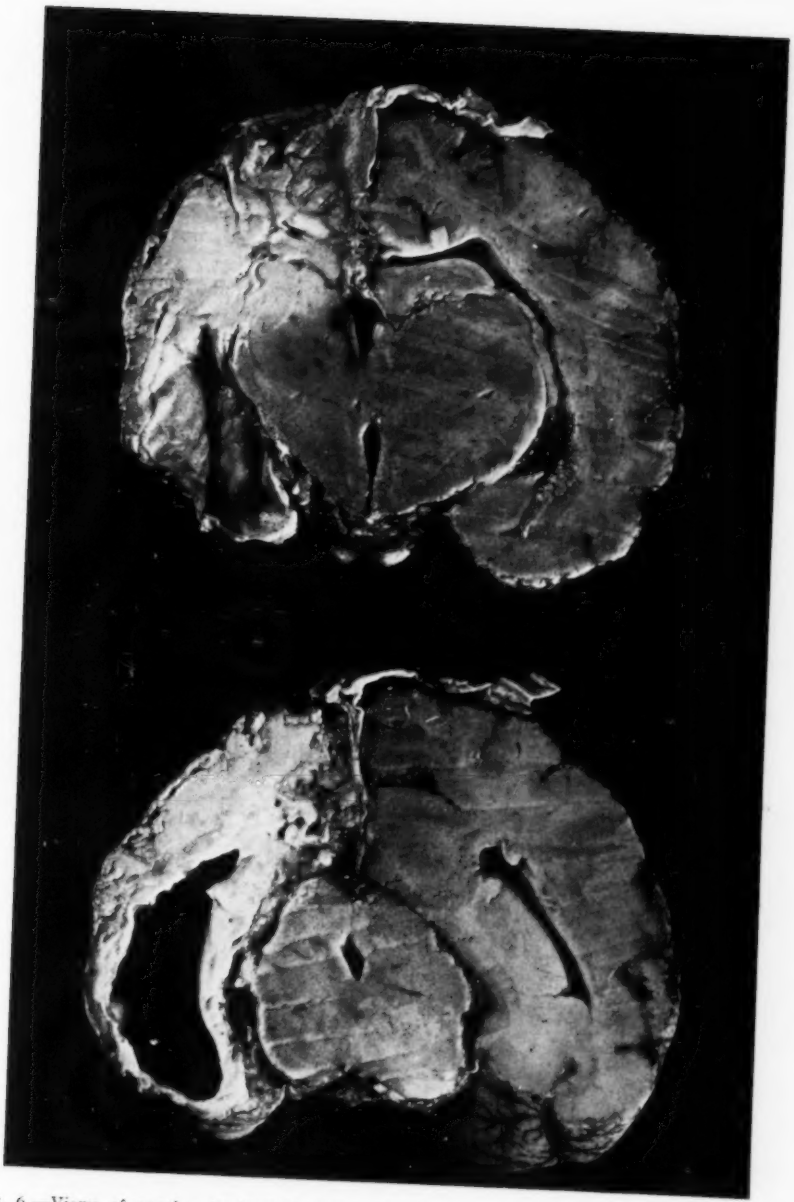


FIG. 6.—Views of another brain with unilateral hydrocephalus. Note the thinning of the cortex as contrasted to the normal (right). The scar in the cortex (upper photograph) is due to closure of the transcortical incision. A ventricular fistula never follows opening the ventricle.

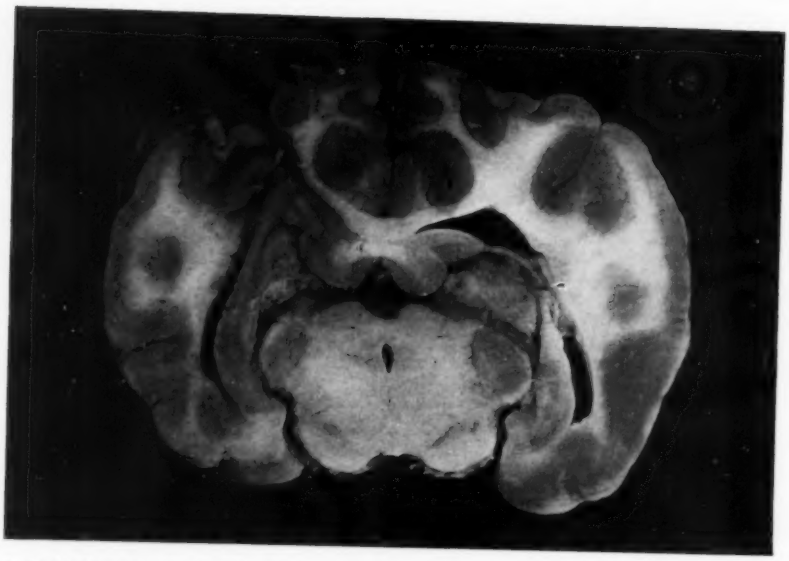


FIG. 7.—Section of a dog's brain three months after the left foramen of Monro was blocked, *but in which the entire choroid plexus of this ventricle was removed*. The left ventricle is a mere slit, the right ventricle is normal. The transcortical defect is shown in the left side. Contrast the left ventricle in Figs. 5, 6, and 7. In all, the foramen of Monro has been occluded but removal of the choroid plexus (Fig. 7) prevents hydrocephalus from forming. This is absolute evidence that the choroid plexus secretes cerebrospinal fluid and that ependyma takes no part in its formation.

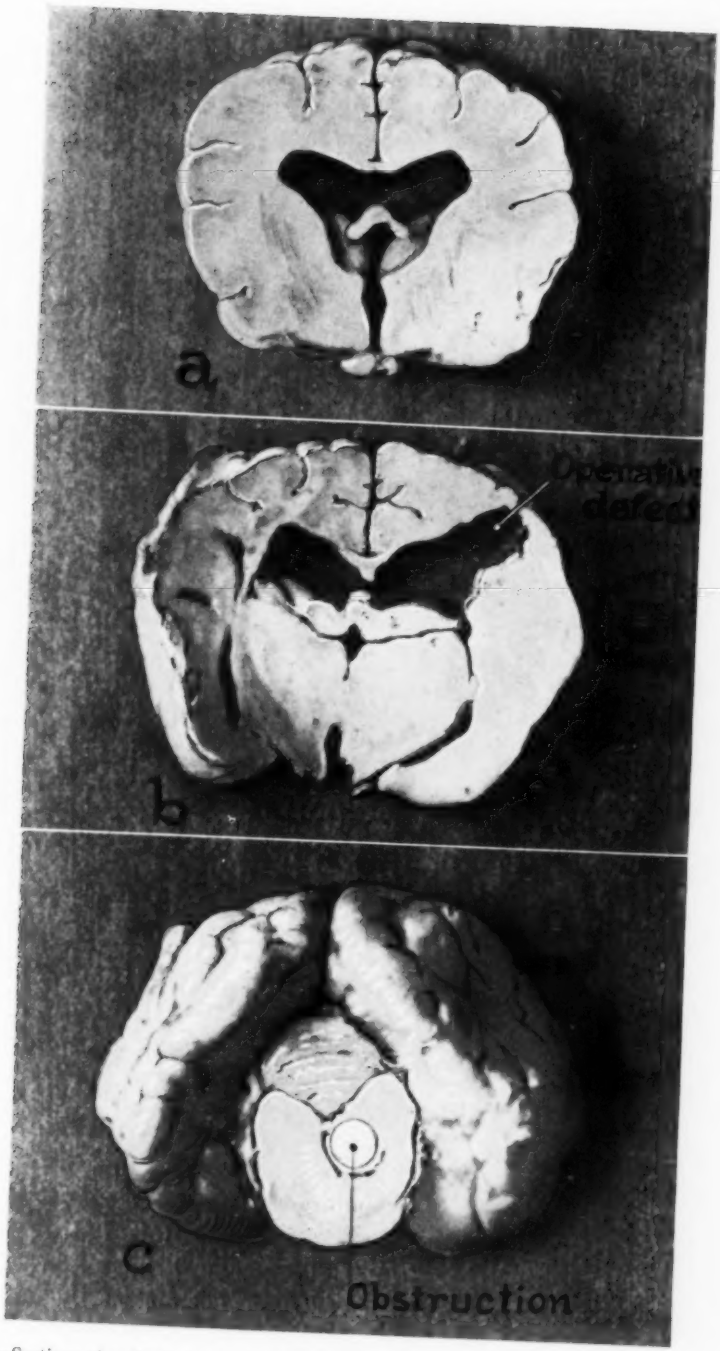


FIG. 8.—Sections of a dog's brain showing hydrocephalus of five weeks' duration resulting after occlusion of the aqueduct of Sylvius, *but in which the choroid plexus of both lateral ventricles was removed* at the same operation. The accumulated cerebrospinal fluid forms solely from the choroid plexus of the third ventricle. Since both foramina of Monro are patent the distention of the lateral ventricles is a necessary sequel to the obstruction in the aqueduct of Sylvius. The remains of the septum lucidum are still evident in *b*. The obstruction (*c*) is slightly beyond the midline but effectively closes the iter.

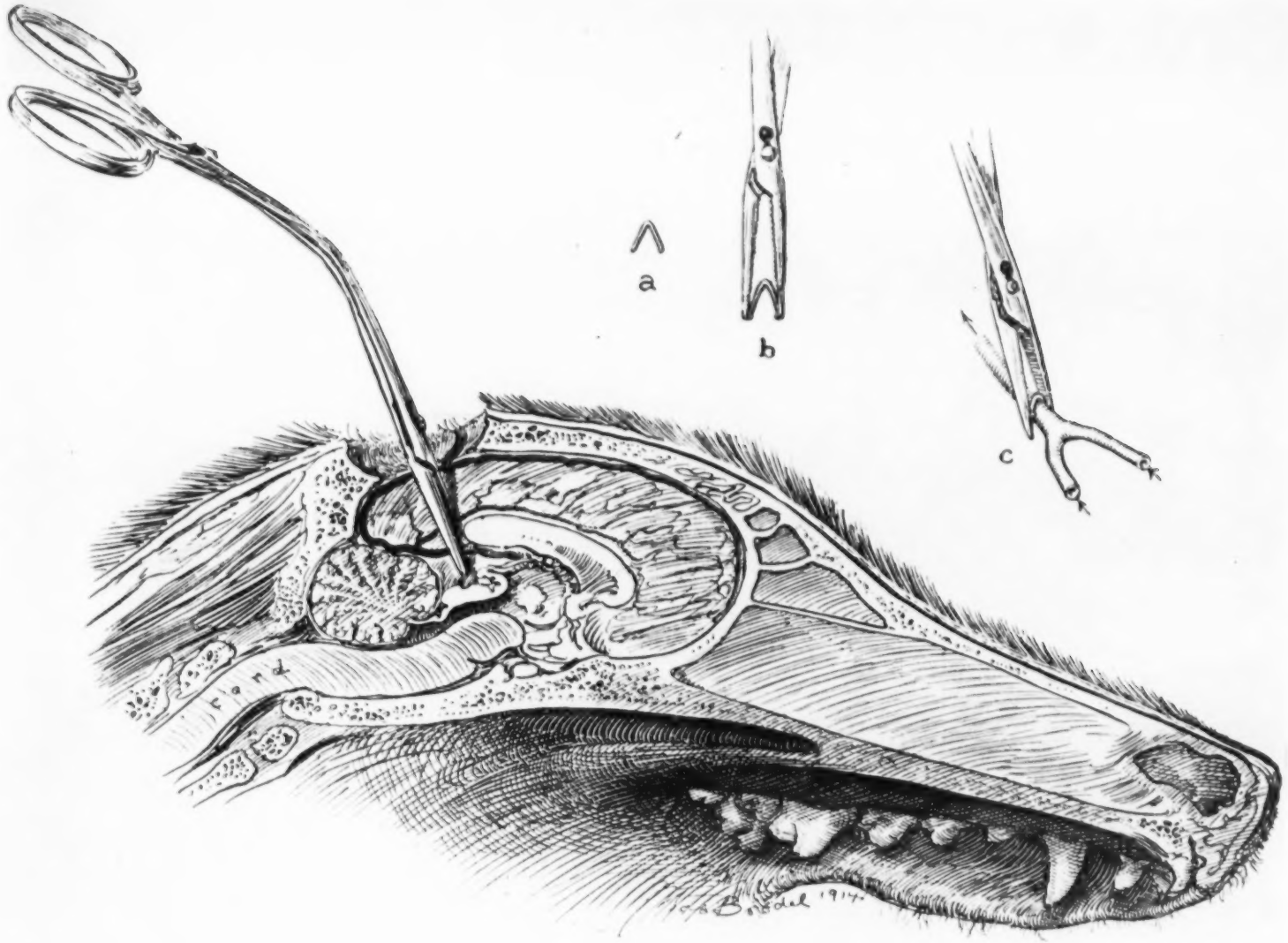


Fig. 9.—Illustration of the method of procedure in ligating the great vein of Galen in a dog. A silver clip is placed astraddle of the vein which is very deeply situated. Compression of the clip occludes the vessel.

trix, probably, of tuberculous origin. I have had under observation a case in which a pedunculated giloma was suspended in the left lateral ventricle and periodically closed the left foramen of Monro. With each occlusion severe headaches, vomiting, partial hemiplegia ensued. Following each attack there was complete subsidence of the signs and symptoms. Doubtless the free intervals were synchronous with the period in which the foramen of Monro was open. Gradually the attacks became more frequent and more violent, and one week before death a final attack began and terminated in death. The affected ventricle was greatly enlarged; the foramen of Monro was completely filled by the tumor which had been forced into the foramen and there became impacted. Part of this obstructing tumor could be dislocated, leaving the foramen of Monro only partially occluded.

The foramen of Monro of a dog can be blocked by inserting either a small piece of fascia or peritoneum (Figs. 3 and 4). Eventually the transplanted tissue becomes incorporated in a cicatrix and total occlusion of the foramen results. The foramen of Monro is reached for this procedure by a transcortical incision which opens into the body of the lateral ventricle well posteriorly. The opening in the brain is maintained by an open nasal speculum. Through this window the foramen of Monro can be seen well forward, where the choroid plexus makes a sharp turn into the third ventricle. The margins of the foramen are scarified before introducing the piece of peritoneum or fascia. The cortical defect is sutured with fine silk. A unilateral hydrocephalus develops on this side (Figs. 5 and 6). There is, of course, no change in the opposite lateral ventricle. Curiously, the cortical opening heals without formation of a ventricular fistula or hernia, despite the total occlusion of the foramen of Monro and the resulting accumulation of cerebrospinal fluid. The healing is similar to the spontaneous closure of an opening made in the corpus callosum for the attempted relief of internal hydrocephalus. It is almost impossible to maintain an artificial opening in a cerebral ventricle.

OCCLUSION OF THE FORAMEN OF MONRO AFTER REMOVAL OF THE CHOROID PLEXUS

The entire choroid plexus of one lateral ventricle can be removed through the same transcortical incision that is made in order to plug the foramen of Monro. If choroid plexectomy is to be done, the incision in the cortex should be even more posteriorly—into the posterior horn of the ventricle—so that the descending horn and the body of the lateral ventricle can be directly illuminated at the same time. The choroid plexus can then be seen through its entire extent. The choroid plexus is picked up with delicate forceps at the foramen of Monro and stripped from its attachment to the velum interpositum as far as the glomus. The tip of the choroid plexus in the descending horn is then picked up and stripped in a similar manner until the glomus is reached. In this way the entire choroid plexus can be removed in one piece.

FIG. 9.—Illustration of the method of procedure in ligating the great vein of Galen in a dog. A silver clip is placed astride of the vein. Compression of the clip occludes the vessel.

Numerous tiny blood-vessels enter the choroid plexus through its narrow edge of attachment to the ventricular wall. The vessels, however, are quite small, and the slight bleeding can be easily controlled by pledgets of cotton moistened in warm saline solution.

If the entire choroid plexus is removed and the foramen of Monro is blocked at the same time, the ventricle becomes obliterated (Fig. 7). A marked contrast is produced by blocking the foramen of Monro on the opposite side without removal of the choroid plexus. Both foramina of Monro being occluded, a collapsed ventricle results on the side from which the choroid plexus has been removed, but the ventricle becomes greatly enlarged on the side in which the choroid plexus is intact. From these experiments *we have the only absolute proof that cerebrospinal fluid is formed from the choroid plexus. Simultaneously it is proven that the ependyma lining the ventricles is not concerned in the production of cerebrospinal fluid.*

EXTIRPATION OF THE CHOROID PLEXUS FROM BOTH LATERAL VENTRICLES FOLLOWED BY OCCLUSION OF THE AQUEDUCT OF SYLVIUS

In a few dogs the choroid plexus was extirpated from both lateral ventricles and at the same operation or shortly thereafter the aqueduct of Sylvius was occluded. In these animals hydrocephalus developed and involved both lateral ventricles and the third ventricle (Fig. 8). There was, however, a pronounced retardation in the development of the hydrocephalus when compared with that which follows the introduction of a similar occlusion, but without a bilateral choroid plexectomy. Hydrocephalus develops because the amount of cerebrospinal fluid which is produced from the choroid plexus of the third ventricle and which cannot escape through the closed aqueduct of Sylvius, is still greater than the amount of the absorption which is possible from the three ventricles. The open foramina of Monro permit the fluid which is formed in the third ventricle to pass freely into and distend both lateral ventricles. We have tried removal of the choroid plexus of the third ventricle, but this has proved unsuccessful. The veins of Galen must be removed together with the roof of the third ventricle to obtain all the choroid plexus from the third ventricle. The animals always succumb to the effects of intraventricular hemorrhage if this operation is attempted. It would doubtless be possible (though we have not done it) to obliterate both lateral ventricles by occluding both foramina of Monro and later to obstruct the aqueduct of Sylvius, thereby producing enlargement of the third ventricle alone.

HYDROCEPHALUS FOLLOWING LIGATION OF THE VENA MAGNA GALENI

Hydrocephalus has often been attributed to an occlusion of the vena magna Galeni or sinus rectus, or both, but in most instances the evidence has been inconclusive. Hydrocephalus forming in this way would be analogous to ascites following stenosis of the inferior vena cava. In either instance the accumulation of fluid indicates an inadequate collateral circulation.

The vena magna Galeni drains the venous blood from the entire interior of the cerebrum, and these vessels, being largely terminal, have but little communication with the extracerebral veins. After the formation of the vena magna Galeni, however, numerous channels establish a free anastomosis between the intra- and extracerebral venous circulation. The basilar, superior cerebellar, temporal, internal occipital, posterior corpus collosal, and other veins bring the two systems into free communication.

Whether hydrocephalus results from venous stasis depends entirely upon the amount of collateral circulation which can develop. If both jugular veins are compressed in a dog, the amount of cerebrospinal fluid is immediately and rapidly increased. This increased production of fluid, however, disappears within a few minutes as the collateral venous circulation becomes established.

As early as 1768 Wyeth looked upon venous obstruction as an important factor in the production of hydrocephalus. Magendie (1825) records a case of thrombosis of the vena magna Galeni and sinus rectus. The symptoms were only of a week's duration, an interval too short to give a demonstrable dilation of the ventricles. As the determination of excess quantities of fluid postmortem is very unsatisfactory and untrustworthy, the diagnosis of early hydrocephalus may be questioned. In the vast majority of cases in which venous stasis is regarded as the cause of hydrocephalus, a tumor has been in the corpora quadrigemina, mesencephalon, corpus pinale, or elsewhere in the vicinity of the vena magna Galeni. Owing to the size of brain tumors, one is not justified in assuming that the hydrocephalus is due to a specific occlusion of the blood-vessels, especially since in the midbrain the aqueduct of Sylvius soon becomes obstructed by tumors; and this we know always results in hydrocephalus.

Undisputed increase of cerebrospinal fluid from a vascular occlusion can be assured only when a pure vascular obstruction exists, as in thrombosis. The authentic cases in which thrombosis of the vein of Galeni or straight sinus has caused hydrocephalus are few, but apparently definite. Newman [7] (1882) reports a case, and Browning [8] (1887) another. Undoubtedly, others have been described but have escaped notice. A few cases of a sharply localized thrombosis of the vena magna Galeni with hydrocephalus are sufficient to establish the causative relationship.

Experimentally, we have been able to establish this point with accuracy. In a series of ten dogs we have ligated the great vein of Galen and the straight sinus in varying places. In a single instance hydrocephalus resulted, and in this case the obstruction was placed at the point of origin of the large vein of Galen (Fig. 10). In the remaining 9 cases the size of the ventricles

[7] Newman, D.: Two Cases of Ventricular Hydrocephalus; One Due to Pressure on the Sinuses by a Tumor in the Cerebellum, the Other to Thrombosis of Galen's Vein. Glasgow M. J., 1882, iii, 161.

[8] Browning, William: A Case of Internal Hydrocephalus Due to Disease (Thrombotic) in the Wall of the Straight Sinus. J. Nerv. and Ment. Diseases, 1887, xli, 260.

was not altered. In other words, hydrocephalus results when an occlusion of the great vein of Galen is located at its origin, but not when the obstruction is placed more distally or along the straight sinus. Above the origin of the great vein of Galen there is apparently sufficient venous collateral circulation to overcome the effects of the obstruction. In dogs, the vein of Galen can be fairly readily exposed at operation by retracting the occipital lobe and carefully dissecting the vein from its bed over the mesencephalon. For a very low occlusion, the splenium of the corpus callosum must be divided. The beginning of the vein of Galen can then be seen just above the pineal body. Ligation of the vessels by a ligature is difficult because of the depth of the wound. The same result is accomplished by compressing a small silver clip over the vessel at the desired point (Fig. 9).

The animal in which hydrocephalus resulted presented no symptoms which distinguished it from the others. The diagnosis of hydrocephalus was made solely from the post-mortem examination. The hydrocephalus developed very much more slowly than that following an occlusion of the aqueduct of Sylvius. In hydrocephalus resulting from venous stasis, all the cerebral ventricles and the aqueduct of Sylvius are enlarged. In gross appearance hydrocephalus so produced is exactly similar to that in the hitherto so-called "idiopathic" or communicating hydrocephalus. The aqueduct of Sylvius, the foramina of Monro, Magendie and Luschka, all become enlarged, because the accumulation of fluid is due to over-production, and there is no obstruction to localize the dilatation. This type of hydrocephalus is different from other chronic types. It is due to over-production of cerebrospinal fluid, whereas other forms are due to a diminished absorption. Possibly this type of hydrocephalus may subsequently be differentiated clinically, but we have had no case under observation. It must be quite rare, for from the pathological examinations of over thirty cases of hydrocephalus we have not encountered a single occlusion of the great vein of Galen or of the straight sinus.

CHANNELS FOR THE CIRCULATION OF CEREBROSPINAL FLUID IN THE SUBARACHNOID SPACE

Before considering the cause and the experimental production of the communicating type of hydrocephalus, it will add clearness to briefly consider the normal channels through which the cerebrospinal fluid is distributed. As heretofore mentioned, all the cerebrospinal fluid in the ventricular system must pass into the subarachnoid space through the three basal foramina of Luschka and Magendie. Of these foramina, not infrequently one or even two may be obliterated, and the third alone will maintain adequate communication. The arrangement of the channels of the subarachnoid space is in a general way that of the trunk and branches of a tree. The basal cisternæ—forming a water-bed under the brain stem and artificially subdivided into the cisterna cerebellomedularis (cisterna magna), cisterna pontis, cisterna interpeduncularis, cisterna chiasmatis—are homologous to the trunk

of the tree. From these cisternæ, fluid is distributed along the major branches of the subarachnoid space which accompany the blood-vessels and traverse the sulci between the cerebral convolutions. The exact number and the relations of the smaller channels have not yet been worked out. The closure of large areas of the subarachnoid space over either cerebral hemisphere, apparently produces no general effects on the absorption of cerebrospinal fluid because the main channels are intact and there is a sufficient absorbing area remaining to easily compensate for this loss. If, however, the cisternæ are obliterated, the trunk is occluded and fluid cannot reach the branches of the subarachnoid space which spread over both cerebral hemispheres. There are no collateral channels which can reëstablish this circulation of cerebrospinal fluid, consequently cerebrospinal fluid cannot reach the cerebral subarachnoid spaces where most of the absorption takes place. An obstruction in the cisternæ is comparable to transection of the trunk of a tree. Whereas death of the tree results from division of the trunk, only local effects result from the destruction of many branches. Occlusion of the cisternæ results in hydrocephalus; many of its branches may be obliterated without hydrocephalus.

The circulation of cerebrospinal fluid can be strikingly demonstrated by substituting India-ink for cerebrospinal fluid in an anæsthetized dog. The ink follows the normal channels of the subarachnoid space; by sacrificing the animals at varying intervals of time after the injection, the various stages of distribution can be observed. Almost immediately all the cisternæ are filled with ink; the cerebellar subarachnoid space also rapidly fills, owing to its intimate relationship with the cisterna magna. Gradually filaments of ink fill the sulci over all surfaces of both cerebral hemispheres; the sulci radiate from the cisterna and appear to anastomose over the cerebral hemispheres. In a series of animals it required from 45 to 75 minutes to reach the most remote spaces along the longitudinal sinus. Very artificial results follow injections of fluids under pressure. Incidentally, if it takes such a long period of time to reach the longitudinal sinus, the hypothesis that absorption occurs through special structures along the longitudinal sinus is immediately vitiated, because normally the rate of absorption from the subarachnoid space is 20 to 25 per cent. an hour (by the phenolsulphonaphthalein test). Therefore, 20 to 25 per cent. absorption has already occurred before the longitudinal sinus has been reached by the dye. Such an hypothesis is also precluded by the fact that a considerable part of this absorption takes place from the spinal subarachnoid space.

THE CAUSE OF HYDROCEPHALUS WITH COMMUNICATION

The type of hydrocephalus in which no pathology has been found and which has been regarded as idopathic hydrocephalus is characterized by dilatation of all the cerebral ventricles and by a free communication between the ventricular system and the subarachnoid space. By the phenolsulphonaphthalein test this type of hydrocephalus has been shown to be caused by

a diminished absorption from the subarachnoid space. It will be remembered that fluid normally forms in the cerebral ventricles but does not absorb there; that absorption takes place only in the subarachnoid space. Therefore, the aqueduct of Sylvius and the foramina of Luschka and Magendie must be patent to maintain the balance between the production and the absorption of cerebrospinal fluid. In communicating hydrocephalus there is a greatly reduced absorption, despite a perfectly free communication. By the phenolsulphonephthalein tests the absorption from the subarachnoid space has been shown to be only 10 per cent. in two hours, or about one-fifth of the normal rate of absorption from this space. The absorption of this dye from the ventricles in communicating hydrocephalus is also about one-fifth of the normal. The ventricular absorption, however, is but a reflection of the absorption from the subarachnoid space, since the absorption of ventricular fluid occurs only after it reaches the subarachnoid space.

In a recent paper [9] this type of hydrocephalus was shown to be due to adhesions which obliterated the cisternæ. The adhesions were not present over the entire brain, but mainly at the base and around the incisura tentorii; that is, where the major effects of meningitis are usually distributed. Obliteration of the cisternæ or a circle of adhesions around the mesencephalon prevents cerebrospinal fluid from passing to sulci over the cerebral hemispheres. Absorption of cerebrospinal fluid is a general process, which takes place from the entire subarachnoid space. With the major part of the subarachnoid space mechanically eliminated by an obstruction in the trunk of the subarachnoid tree, the area in which absorption of cerebrospinal fluid can occur is limited to about one-fifth of the normal amount. Consequently, hydrocephalus results from a greatly diminished absorption. In reality, therefore, communicating hydrocephalus is caused by an obstruction, and differs from the so-called obstructive hydrocephalus only in the location of the obstruction. To disclose adhesions and obliteration of the subarachnoid space, the brain must be carefully removed and studied during its removal. A subsequent examination of the brain reveals but little, because the adhesions have all been liberated by removal of the brain, and the gross appearance of thickened pia-arachnoid is not striking after fixation. A striking demonstration of the location of the obstruction will no doubt result by injecting colored solutions into the spinal canal under minimal pressures. The colored injection mass, of course, will stop at the obstruction. This color contrast will be seen in one of the cases of experimental hydrocephalus which will appear in the following pages. A demonstration equally striking can be shown in the living by intraspinous air injections. These observations will appear in a subsequent paper.

These pathological findings are in perfect harmony with the appearance of the brain at operation. At operation, in both the obstructive and the communicating types of hydrocephalus, the sulci over the hemispheres are seen to be shallow and contain but little fluid. If the subarachnoid spaces

[9] Loc. cit., Am. J. Dis. Child., 1917, xiv, 424.

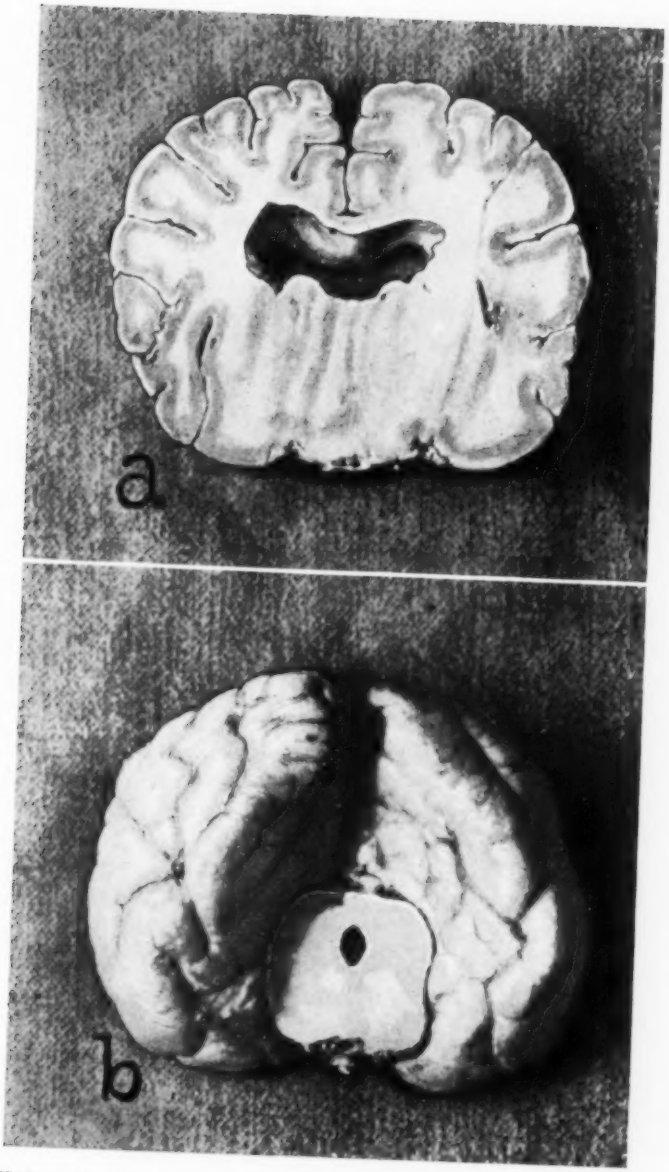


FIG. 10.—Hydrocephalus of three and one-half months' duration, resulting from a ligature on the vena magna Galeni near its origin. The aqueduct of Sylvius is also enlarged. This form of hydrocephalus results from an overproduction of fluid; all other forms from a diminished absorption of fluid.

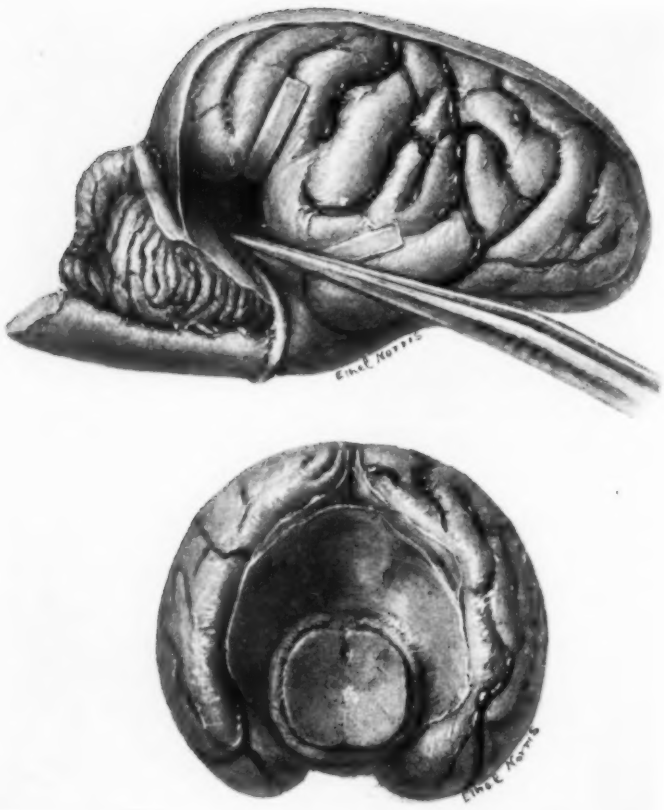


FIG. 11.—Drawings by Miss Norris to show method of placing a perimesencephalic band in position, and also to show its approximate location. The lower figure shows the band in place. Adhesions form between the brain and the gauze and occlude the cerebrospinal spaces, including the cisterna. "Communicating" hydrocephalus results from this procedure.

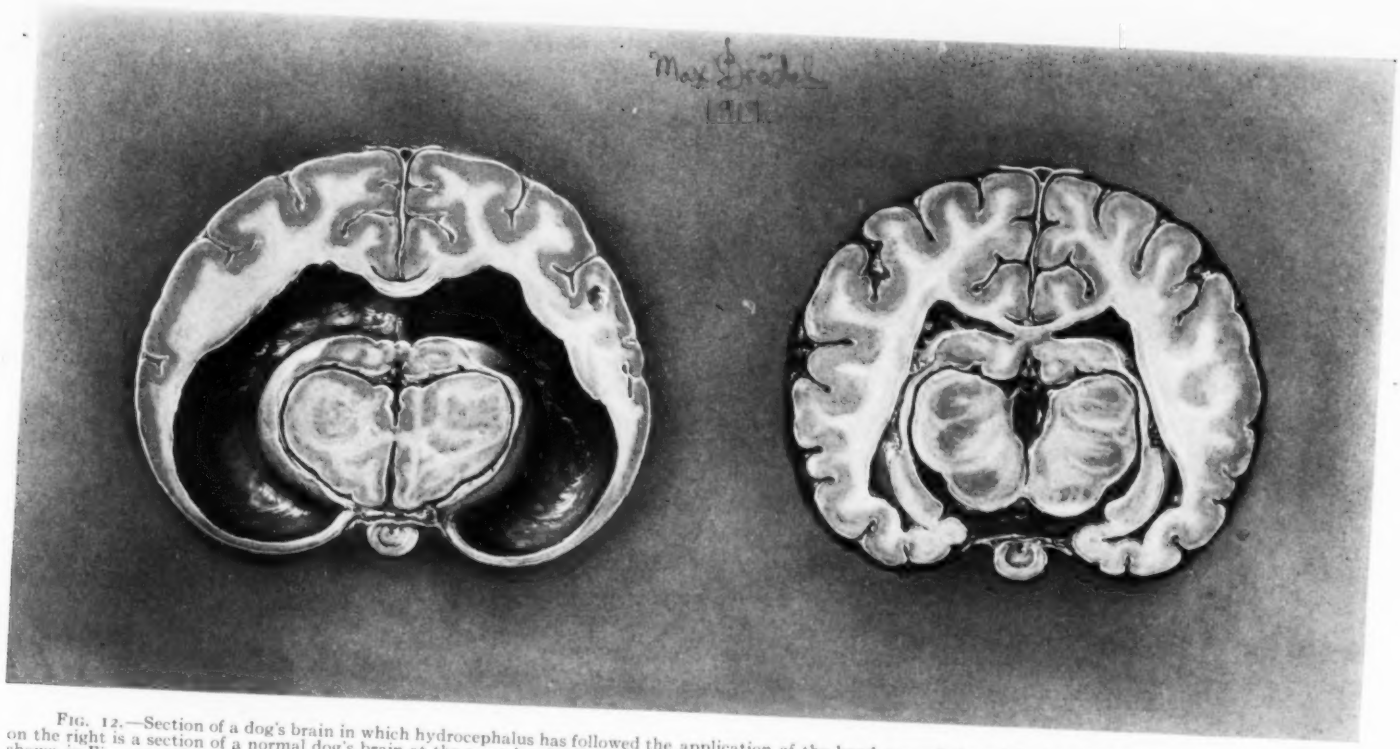
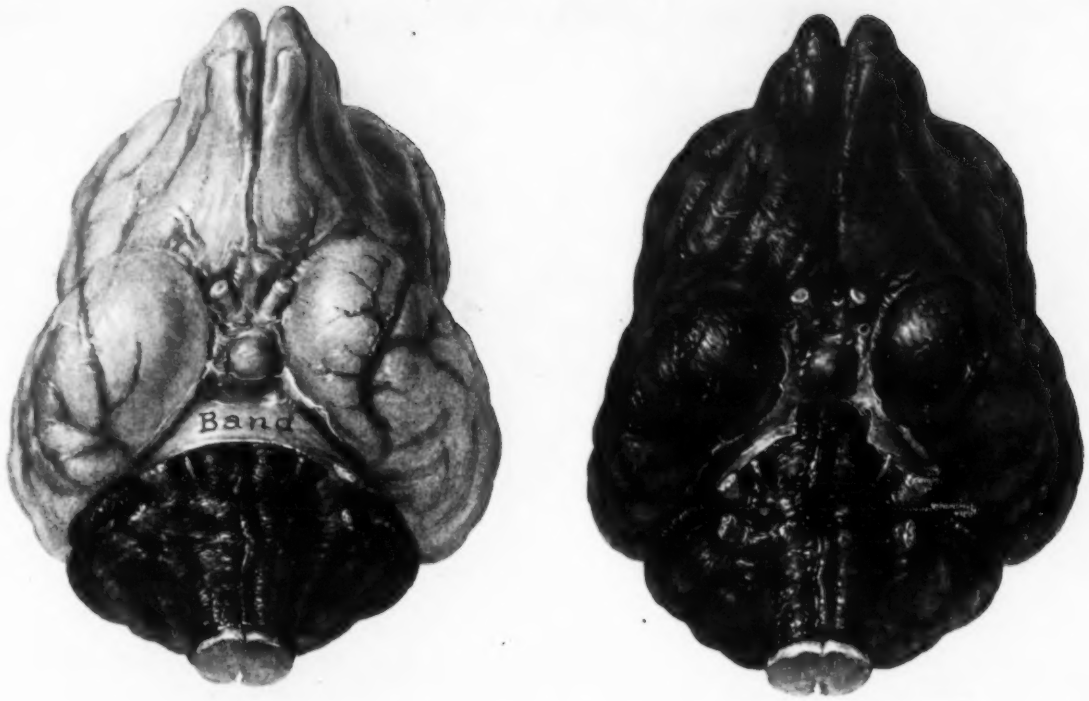


FIG. 12.—Section of a dog's brain in which hydrocephalus has followed the application of the band around the midbrain, as described in Fig. 11. The figure on the right is a section of a normal dog's brain at the same level. The hydrocephalus is of three months' duration. These sections are taken from the brains shown in Figs. 13 and 14. Compare the ventricular dilatation with that in Fig. 10, in which the vein of Galen was ligated. Drawing by Mr. Brödel.



A B

FIG. 13.—Drawings by Mr. Brödel, showing the result of injections of India ink into the spinal canal two hours before the animals were sacrificed. On the right the entire brain is colored black, as occurs normally. On the left the ink stops at the perimesencephalic band and can get no farther. In other words the black area represents the amount of subarachnoid space reached by the cerebrospinal fluid—*A*, in the animal in which a band is around the midbrain, and *B*, the normal. Hydrocephalus of the "communicating" type results because most of the absorbing area of subarachnoid space has been eliminated by this extraventricular obstruction.

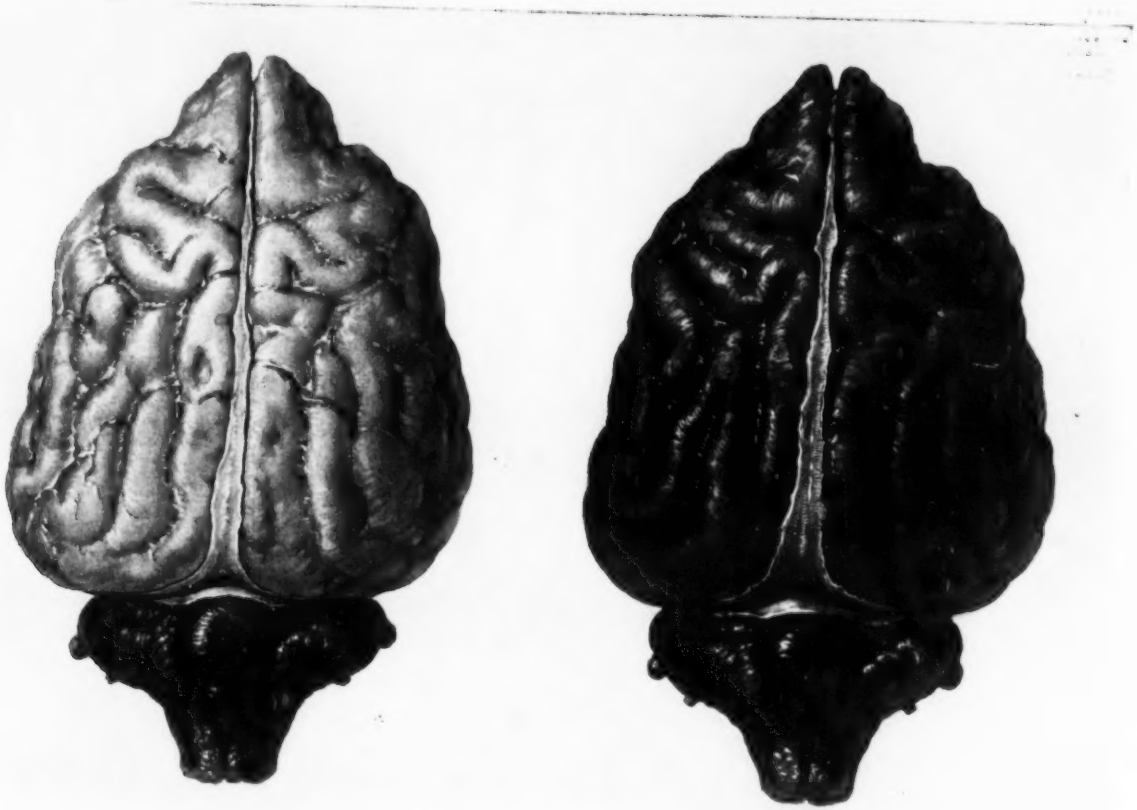


FIG. 14.—Drawings by Mr. Brödel of dorsal view of same brains as Figs. 12 and 13. It will be seen that the black ink stops at the tentorium cerebelli, it covers the cerebellum completely but none of the subarachnoid space over either cerebral hemisphere is reached. Section of these brains is shown in Fig. 12. Mr. Brödel has shown the light and dark surfaces of the brain in transverse sections also (Fig. 12). The ink filled the ventricles in the hydrocephalic brain but did not reach them in the normal brain (Fig. 12).

were not obstructed at the regions mentioned, fluid would accumulate in the sulci and cause their dilatation up to the point of obstruction, just as bile accumulates up to the obstruction in the common bile duct. There is but little fluid in the cerebral sulci because the barrier of adhesions has prevented the cerebrospinal fluid from reaching the cerebral hemispheres. As mentioned previously, the physiological tests (by phenolsuphonephthalein) show about one-fifth of the normal absorption from the subarachnoid space, apparently indicating a reduction in the subarachnoid space to one-fifth of its normal area.

THE EXPERIMENTAL PRODUCTION OF COMMUNICATING HYDROCEPHALUS

The absolute test that the pathological findings described for communicating hydrocephalus are correct lies in the ability to reproduce this disease in animals. The effects of meningitis are so diffuse that differences of opinion in the interpretation of the findings are permissible. A single, sharply defined experimental lesion eliminates speculation. The experimental methods which I have used were suggested by the results of the physiological phenolsulphonephthalein tests, and were developed before any pathological material had been obtained.

The object of the experiments is to eliminate the subarachnoid space above the incisura tentorii, and thereby to exclude the entire cerebral subarachnoid space from participation in the absorption of the cerebrospinal fluid. A glance at the intracranial topography will show that the only communication between the posterior and middle cranial fossæ is through the incisura tentorii, through which the mesencephalon passes. Except for this opening, the tentorium cerebelli acts as an impermeable diaphragm, which divides the cranial chamber into two cavities. We propose to produce adhesions around the entire circumference of the midbrain where it traverses the incisura tentorii (Fig. 11). This will obliterate by a circular band the subarachnoid space along the midbrain. The principal part of the subarachnoid space which will be obstructed by this procedure will be the cisterna. This cisterna is the part of the main trunk through which all the cerebrospinal fluid must pass. In other words, if the experiment is successful, cerebrospinal fluid cannot pass beyond the posterior cranial fossa into the middle, and thence subsequently also the anterior, cranial fossæ. *All cerebrospinal fluid enters the cisterna magna from the fourth ventricle,* but the experimental obstruction prevents it from passing into the cisterna interpeduncularis and cisterna chiasmatis. The cerebrospinal fluid therefore cannot reach the subarachnoid space which forms a mantel over both cerebral hemispheres. By eliminating the entire cerebral subarachnoid space the amount of absorption of cerebrospinal fluid should be tremendously reduced and hydrocephalus should follow.

This sharply defined area of adhesions can be produced by encircling the midbrain with a tiny strip of gauze which has been saturated with an irritant.

In the course of time a circle of adhesions forms between the margins of the incisura tentorii and the midbrain.

The technic of this procedure is as follows:

A subtemporal bony defect is made on each side and extending posteriorly to the tentorium (osseum in the dog) and inferiorly to the base of the skull. The temporal and occipital lobes are elevated on one side with a spatula until the carotid artery and third nerve are brought clearly into view. With a little additional elevation these structures are put on a stretch and the inferior surface of the midbrain can be seen. The third nerve is the most important landmark. The end of the gauze strand is passed under the mesencephalon to a point on the opposite side of the brain and emerging contralaterally just behind the third nerve. The operator then shifts to the opposite side of the table and elevates the other side of the brain until the third nerve is exposed on this side. The end of gauze will then be seen protruding and can easily be grasped with forceps. By gentle traction half of the strip of gauze is pulled under the midbrain, so that an equal length of gauze is on either side. The brain is then allowed to settle. The next step consists in retracting the occipital lobes forward, first on one side and then on the other, until the margins of the incisura tentorii can be distinctly seen. The gauze strip is then carefully inserted between the midbrain and the margins of this dural opening. The gauze is then in close apposition to the entire circumference of the midbrain and also of the dural edge. (Fig. 11.)

It has been found by experience that it is necessary to saturate the gauze with iodine in order to produce adhesions. Gauze not so treated becomes incorporated as a smooth foreign body, without adhesions, and has no effect upon the continuity of the subarachnoid space, and consequently there is no effect upon the distribution of cerebrospinal fluid. It is entirely probable that the irritant alone will produce the same result. In areas over the surface of the occipital lobe, which was unavoidably touched with the iodine, firm adhesions bound the tentorium to the brain. There has been no mortality incident to this operation.

Following the application of the perimesencephalic band, hydrocephalus develops almost as rapidly as following occlusion of the aqueduct of Sylvius (Fig. 12). That the subarachnoid space around the midbrain is obliterated by adhesions can be graphically demonstrated, by substituting India-ink for cerebrospinal fluid in the cisterna magna two hours before the animal is sacrificed. The ink granules are distributed through every part of the subarachnoid space which is open to the cerebrospinal fluid. By fixing the brain with intravascular formalin the ink granules are deposited, making a striking and permanent record. Normally, ink so introduced into the subarachnoid space will cover the whole brain in this period of time and a small amount may even pass through the foramina of Luschka into the fourth ventricle. When hydrocephalus results from a perimesencephalic barrier of adhesions, the ink cannot pass beyond this obstruction (Figs. 13 and 14). On the other hand, in the specimen of hydrocephalus which has resulted from the perimesencephalic band, all the dilated ventricles are full of ink because the foramina of Luschka (the foramen of Magendie is absent in the dog) are enlarged, permitting an easy backward passage of cerebrospinal fluid into all the cerebral ventricles. Although valves are not present, normally the approximation of the cerebellum to the medulla prevents more than a

trace of the colored fluid, which is in the spinal canal, reaching the ventricles. In experimental communicating hydrocephalus the presence of such a large amount of ink in the ventricles, together with a sharp color-line at the obstruction, is positive proof that there was ample opportunity for ink to reach the cerebral subarachnoid space if it were possible. This barrier of adhesions was therefore the sole cause of the hydrocephalus. The accumulation of fluid can be explained by assuming a reduction in the amount of the area for the absorption of cerebrospinal fluid. The dilatation of the aqueduct of Sylvius and presence of ink in the lateral ventricles also demonstrate that the circle of adhesions around the midbrain did not in any way constrict the aqueduct of Sylvius and thereby cause the hydrocephalus. The band of adhesions need not hermetically seal the subarachnoid space to produce hydrocephalus, for in one case a slight channel permitted a little fluid (ink) to trickle through for a short distance. It is entirely possible that if adhesions are not too dense such tiny channels may eventually dilate and modify the rate of development of the hydrocephalus or even overcome the effects of obstruction, and reaching the cisternæ beyond, reëstablish the continuity between the cerebellar and cerebral subarachnoid spaces. Spontaneous cures of hydrocephalus not infrequently occur, and such a development could readily afford an explanation.

SUMMARY AND CONCLUSIONS

1. Hydrocephalus has been produced by placing an obstruction in the aqueduct of Sylvius. Dilatation of the third and both lateral ventricles results.

2. One foramen of Monro has been occluded; this is followed by a unilateral hydrocephalus.

3. If the choroid plexus of one lateral ventricle is completely removed at the time the foramen of Monro is occluded, not only does no dilatation occur, but the entire lateral ventricle collapses.

4. This is the only absolute proof that the cerebrospinal fluid is formed from the choroid plexus. At the same time it proves that the ependyma does not secrete cerebrospinal fluid.

5. If the choroid plexus of both lateral ventricles is removed, and an obstruction is placed in the aqueduct of Sylvius, hydrocephalus still results in the third and both lateral ventricles, but at a reduced rate. The fluid forms from the choroid plexus of the third ventricle but cannot escape into the subarachnoid space.

6. Cerebrospinal fluid forms in all the cerebral ventricles. It is absorbed almost entirely in the subarachnoid space. The sole communication between the ventricular system and the subarachnoid space is through the foramina of Luschka and the median foramen of Magendie.

7. The phenolsuphonephthalein test will prove conclusively whether the foramina of Luschka and Magendie are open or closed. Closure of these foramina invariably causes hydrocephalus.

8. Hydrocephalus follows ligation of the vena magna Galeni if the ligature is placed at the origin of this vein. Ligatures beyond or in the sinus rectus have no effect because there is sufficient venous collateral circulation.

9. The communicating type of hydrocephalus has been produced in dogs by a perimesencephalic band of gauze, saturated in an irritant which induces adhesions. This obstruction prevents cerebrospinal fluid from reaching the cerebral subarachnoid space where most of the cerebrospinal fluid is absorbed. The resultant diminished absorption of fluid results from hydrocephalus.

10. Hydrocephalus follows ligation of the great vein of Galen because of an overproduction of cerebrospinal fluid. In other types of hydrocephalus, both obstructive and communicating, the accumulation of fluid is due to a diminished absorption of cerebrospinal fluid.

CONCUSSION OF THE BRAIN

A STUDY IN DIAGNOSIS

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Many pertinent facts can be brought out in the study of a single case, especially where you have the coöperation of specialists in various fields.

The following case of cerebral concussion is interesting, especially as a diagnostic problem. There was considerable doubt as to the diagnosis for some time. The patient had been seen by a number of men previous to his coming to our hospital, and different opinions had been given. The case was instructive in many ways. Expectant treatment in a hospital where a large staff is available for consultation is relatively a safer procedure than in private practice, of course.

Case I.—H. C., private, 106 Inf. of Brooklyn, twenty-four years old, was admitted to U. S. A. Base Hospital No. 37, Dartford, Kent, England, by transfer from the 18th General Hospital, Boulogne, France, on August 10, 1918. There was only a brief history accompanying the patient. It is stated that he was a stenographer in private life. In the Army he had been a trusted runner, carrying important messages, when his regiment was in action. Except for a tendency to "catch cold" frequently, his previous history was negative.

We knew but little of the circumstances immediately connected with his injury, except that he was picked up unconscious on the battlefield, and remained in that condition for a number of hours. The only visible evidence of injury was a contusion on the forehead, and on the right wrist. He was able to open his mouth, but could not protrude his tongue, for some time after reaching the clearing station. There was no rigidity of the neck. When he became a little clearer, he complained of headache and dizziness.

A few days later, he began to notice marked tinnitus in the right ear. There appeared a foul discharge from this ear now for the first time. He had vomited only twice in all. He was nauseated. If he tried to sit up in bed, his dizziness was increased.

At the end of the second week he was still dull and apathetic. The least movement in bed made his headache much worse. For the past ten days there was blurring of vision: in fact, he said his vision had not been clear since the accident. He had lost much flesh and strength, and looked sick. Soon after his admission to my wards, I had the aurist see him. He said both ear drums were retracted; the right one showed an old perforation. An X-ray examination showed an old sclerosis of the right mastoid.

The discharge from his ear later stopped quite suddenly. His general condition remained about the same.

His pulse, respiration and temperature chart gave us no positive aid. Careful X-ray examination of the skull showed no evidence of fracture.

Numerous urinalyses were all negative; except on one occasion, when there was a faint trace of albumen.

A number of blood examinations were made. They were not particularly helpful. The following is a sample one: Red cells, 5,170,000; hæmoglobin, 65 per cent.; white cells, 7600 (small mononuclears, 49 per cent.; large mononuclears, 1 per cent.; polymorphonuclears-eosinophiles, 3 per cent.; polymorphonuclears-neutrophiles, 47 per cent.).

The Wassermann examination of the blood and spinal fluid was always negative. The spinal fluid was clear at all times. It showed no evidence of blood, and contained only two cells per mm.; globulin was negative. It was not under pressure.

A study of the pulse, temperature, and respiration chart for over a month was only of negative assistance. The temperature ranged from 97° to 100° F., except on three occasions, when it was between 96° and 97° F. The large majority of readings were between 98.2° F. and 98.8° F. His pulse during this period varied from 60 to 114; the majority of the times being between 74 and 88. It showed a greater variability than the temperature. It never showed a low rate on two days in succession. His respirations, while under our care, were always 18 to 20.

He continued to give us a great deal of concern. His apathy continued, he took no interest in his surroundings; yet before his accident he was a bright young man. Naturally the possibility of a brain abscess was always present, because of his general condition, and the otitis media, and the fact that the discharge resulting from it had suddenly stopped. When his sensorium became clearer, he spoke spontaneously of the appearance of a very disagreeable odor, of short duration, that preceded all his early attacks of dizziness. He did not have this phenomenon now. This worried us somewhat, as this symptom has been reported in cases of temporo-sphenoidal abscess.

The possibility of the case being one of dementia præcox was discussed, but not only the history and neurological examination, but the psychiatric analysis would eliminate this as a diagnosis. His lowered emotional tone, poor association of ideas, apparent indifference, lack of interest, and hearing of noises could readily be explained on physical grounds, due to cerebral concussion. The same holds true for his defective impressibility of memory, his poor past and worse present memory, and his inability to credibly perform intelligence tests, as we will show in speaking of the symptoms of cerebral concussion. He could not grasp the situation, nor understand clearly, nor hold the thread of conversation well—all due to his confusional state, incidental to the commotio cerebri—and not to any dementia præcox mechanism. He not only showed no real

volitional deterioration, nor a refusal to coöperate, as in dementia præcox, but rather gave you all the aid he could when he understood. In fact, he tried hard to aid the physicians. Another reason given in corroboration of his being a præcox, was that he was self-centred. But a careful psychological study of his personality showed him to be recessive in many of his tendencies; oversensitive, and possessing a moderate inferiority-complex. So being self-centred was merely in keeping with his habitual attitude.

Nor was his clouding of consciousness as marked as we see in an infection-exhaustion psychosis. For he was only moderately confused, and showed practically no disorientation. Had he been suffering from a mild case of exhaustion psychosis one would have expected periods of changed moods, and irritability; and also a marked improvement at the end of six weeks. So to us it was evident that any emotional-volitional disturbance was a secondary and not a primary one.

He was given a careful neurological examination on a number of occasions. We will not give all the details of the examination, but only the more important facts. Though the ophthalmologist examined the fundi a number of times, there was never any papill-œdema. He continued to look ill; he seemed dazed, and was content to lie quietly, full dressed, on his bed. He appeared sad; though when spoken to, it cheered him somewhat. The vertigo was gradually disappearing. His chief complaint was a fairly continuous, severe, dull headache over the frontal and both temporal regions, which was made worse by exertion. There has been but little nausea of late. Except for the few times in the early days of his illness, there has been no vomiting. There was no hypertonia of the extremities. They, of course, were generally weak, in agreement with his general feeling of weakness. The deep reflexes were generally exaggerated—jaw, ankle, knee, and achilles—the left knee, and left ankle especially. There was a bilateral exhaustible ankle clonus—more marked on the left side. Abdominals and cremasterics were present and lively. No Babinski was elicited, but he had had a few lumbar punctures recently, and I have frequently found it absent, even when formerly present, after doing a puncture. There was a partial and irregular hemianæsthesia and hemianalgesia on the right side, more pronounced in the arm. It was very unlike the sensory disturbances seen in hysteria—not approaching the middle line in front, and in the back—not only was the limit of anæsthesia far away from the middle line, but it was very irregular. Position, pressure, and muscle senses were good. There was no asynergy. There was no paralysis, no atrophy, no spasms. There was no adiadochokinesis. He spoke in a low, slow voice, but there was no real dysarthria. He had a lateral nystagmus, more to the left. His vertigo had almost disappeared. Bone conduction was absent on the left side. No matter where you placed the tuning-fork on the skull, he heard it in the right ear. The purulent discharge from the ear had stopped now.

His pupils were equal, unduly dilated, and would not react to light: it was, at this time, over two weeks since atropine had been dropped into his eyes by the ophthalmologist. The right palpebral fissure was slightly smaller than the left. Slight equal contraction of the visual fields. In the early part of his illness, he had had diplopia, but there was none now. But he still has blurring of vision (existing even before atropine was put in the eyes).

His left labio-nasal fold was less prominent than the right, and the left side of the face showed less play of the muscles than on the right side. Both ear drums are retracted. Right mastoid shows an old sclerosis. Pulse, 72; temperature, 97.8°; respiration, 20.

He was under careful observation all the time. After the onset he continued to be apathetic, though his general condition was somewhat improved. He would sit in a chair for short periods, and walk about the ward. We tried to keep him as quiet as possible, for we had not ruled out a brain abscess. He had been sent over to us from France with the diagnosis "Vertigo; Derangement of the Internal Ear."

To us the two most probable conditions which were the cause of the patient's illness were cerebral concussion and a brain abscess, involving either the temporosphenoidal lobe or the cerebellum.

A simple neurosis was easily ruled out by the history and the neurological examination. (The term "shell shock," being a misnomer, was never used in the U. S. Army as a diagnosis.) To diagnose the condition as a psychoneurosis would have been extremely erroneous, for we were not dealing with a simple fatigue neurosis—a neurasthenia; and he certainly was suffering from something more than a mere hysterical reaction to a difficult situation.

The diagnosis of vertigo was only naming a symptom, and the diagnosis "Derangement of the Internal Ear" would certainly not explain his whole condition.

The clinical signs, including the X-ray examination, were against a fracture of the skull. As we well know the important thing in a fracture of the skull is the danger of injury to the brain—either immediate, or later from compression. Localizing signs are often absent. In our patient there was no slowing of the pulse, no high spinal pressure, nor blood-tinged fluid, no choked disc, and no vomiting (except twice in the early part of his illness). He did present some evidences of a possible fracture of the skull—as a disturbed sensorium and unduly dilated pupils which did not react to light. But, of course, we find these phenomena in other conditions. We know that involvement of the seventh, sixth, and third cranial nerves is frequent in fracture of the base; they, too, are involved in other conditions.

In estimating spinal fluid pressure, you take 70 to 120 mm. of water, or 5 to 8 mm. of mercury, as being the normal limits. Saying that 20 to 40 drops per minute is a normal rate of flow, is hardly a scientific and accurate way of estimating pressure, when we consider the various factors which might modify this rate. In this case

there was no increase in the pressure. In our experience, the examination of the eye grounds is a more valuable aid in diagnosing increased intracranial pressure than the estimation of the spinal fluid pressure. In this case there was no increased cell count, no increase of globulin, and the spinal fluid was not blood-tinged: which was all against a fracture of the skull; and also against an intradural hemorrhage.

So, too, the clinical signs and the course of the disease, and the negative spinal fluid, were against a meningitis, either traumatic or secondary to the ear condition. There was no rigidity of the neck, nor general muscular rigidity, and no Kernig sign. Nor was there any hyperæsthesia. The pulse, respiration, and temperature observations were also against a diagnosis of this condition.

It was necessary to rule out two conditions before we arrived at our final diagnosis; one of these was labyrinth disease. For at first hand there was an apparent Ménière syndrome. Ordinary labyrinth symptoms are dizziness, pain in the ear, tinnitus, deafness and vomiting. Then there was the possibility of a brain abscess.

In labyrinth disease the vertigo is due to involvement of the vestibular nerve. It is frequently of short duration. There is nearly always an accompanying nystagmus. Spontaneous nystagmus does not occur in labyrinthine shock. There was no rotary nystagmus, and no vomiting after the first few days, and but little nausea. In a true Ménière syndrome, you get severe attacks of nausea and vomiting. The tests applied did not indicate that the labyrinth was the cause of his symptoms. (Some of the French authorities say vomiting and nausea may be absent.) Unfortunately, the aurist left no notes about Bárány or pointing tests. The physical signs, of course, could not be explained by internal ear disease alone.

The discharge from the ear—he had a suppurative otitis media—was the suspicious element; it could be an etiological factor, but also in the case of a brain abscess, where it is the most frequent causative agent.

The possibility of a brain abscess—temporo-sphenoidal or cerebellar—was the thing that gave us the most concern. We naturally did not want to order a decompression unless it was really necessary, and likewise we did not want to delay ordering it if an abscess was present. The spinal fluid examinations were against an abscess. However, if it were deep-seated, with no meningeal involvement, one would expect the fluid to be negative. So, too, as for papillœdema, we know it is often absent in abscess, even if cerebellar. The failure to get any light reaction in the widely dilated pupils also concerned us; this lasted for three weeks, and then we got a sluggish response. About three weeks before, he had had atropine dropped in his eye by the ophthalmologist. He had complained of a blurring of vision since the early part of his illness. His fundi and optic nerves were normal. We thought that his visual disturbance was central in origin.

It is a well-known fact that an abscess in the temporo-sphenoidal lobe—the most common site of abscess from an otitic cause—frequently gives little or no focal symptoms; and sometimes but few general symptoms. Examination by X-ray did not aid us. In abscesses situated here, there may be certain disturbances of smell; or signs of indirect pressure on the pyramidal tracts; and in abscesses in the left lobe, there may be aphasic signs.

More than half of all brain abscesses are secondary to purulent diseases of the ear. The course is extremely variable—from days to years. A sudden cessation of a purulent ear discharge is often of grave significance. So our anxiety was not relieved when it occurred in this case. But at no time was his pulse consistently slow. Nor were there any temperature changes which were characteristic. The differential blood examinations were negative. There was no choked disc. The persistent headache, dizziness and lowered mental tension were suspicious phenomena.

The cerebellum is frequently the site of abscess, following middle ear disease. In this case there were certain signs suggestive of a cerebellar lesion; especially the vertigo, and a reeling sort of gait later on in the course of his disease. Were the vertigo a pure cerebellar affair, defective hearing and ear disturbances would not be present. Vestibular vertigo differs from cerebellar vertigo in that it changes with the position of the head, in any of the three planes. Cerebellar vertigo is rotary in character. The patient may fall toward the affected side. The gait is often tumbling: toward the side of the lesion. Asynergy and adiadochokinesis are usually present. (They were absent in this case.) Of course, besides an abscess, one had to think of small hemorrhagic foci, involving also the cerebellum, as the result of the concussion.

The cerebellum synergizes body movements. So a cerebellar lesion will cause symptoms due to asynergy—as tremors, adiadochokinesis, and nystagmus. Adiadochokinesis, if present, is corroborative; but, of course, it occurs in other than cerebellar conditions. In a cerebellar condition the gait is a trunkal one—the legs seem to follow the trunk. The shoulder or the pelvic girdle may be chiefly involved. You may notice swaying of the body when the patient is sitting. It might be well to remark here, that the cerebellar ataxic does not widen his base in walking (by separating his feet) as the tabetic ataxic does. It is a fact that without ataxia, of course, no cerebellar lesion can be diagnosed with certainty. At times you only get a hemiataxia, on the side of the lesion. Nystagmus is rarely absent in cerebellar disease, especially when looking to the side of the lesion. But spontaneous nystagmus is more of a bulbar than a cerebellar sign. Speech is drawling and slow. Headache in cerebellar conditions is usually occipital, and usually violent.

In a cerebellar dysarthria, the speech disturbance is due to ataxia of the tongue muscles. This was not the cause in our patient. The patient did show some unilateral facial weakness. In the beginning there was a paralysis of the tongue, but this soon cleared up.

So taking all things into consideration, we felt that our patient's condition could not be explained as being due only to a cerebellar lesion.

Thus, by exclusion we concluded that we were dealing with a severe case of cerebral concussion. There were probably a number of scattered punctate hemorrhagic areas throughout the brain. It is true that most of the signs favored the right side of the brain.

In severe cases of cerebral concussion, the patient may be unconscious for hours or days. Blood may be, or may not be present in the spinal fluid. There may be retinal hemorrhages.

It might be of interest to note here a few of the results caused by high explosive shells. Marage, of Paris, says the velocity of the sound wave is 333 metres a second, under atmospheric pressure; but near an exploding shell, the speed of a shock wave is as great as 2000 metres a second. But this is only so for a short distance; for at 60 metres distance, the velocity is that of sound. In this danger zone of 60 metres, the pressure is increased as high as 200 kilograms to the square centimetre; but it lasts only 1/100 of a second. Under this pressure, the blood is driven toward the centre, *e.g.*, the brain. It is checked, of course, by the capillaries—otherwise the fatal cases would have been much more numerous. Mott, of London, says that the force generated by a 17-inch shell equals 10 tons to a square yard. But the cerebrospinal fluid acts as a water cushion to the cord and brain.

In this patient we think there were numerous small hemorrhagic lesions in the brain. We also think that the ear condition existed in the rôle of a coexistent disease, and was brought into evidence by the shell explosion. But we do not think it was the cause of all of his symptoms and signs.

In severe cases of concussion, you may first get stupor, followed by apathy. Then you notice a marked disturbance of mental tension—difficulty in thinking, disorientation, memory poor for the past, and absent for the present, with nearly always a retrograde amnesia; difficulty in calculation, and slowness in all actions. Certain symptoms—as headache and a staggering gait, and a clouded sensorium—may persist for a long time. The history, physical signs and course show this to have been a severe case of cerebral concussion.

We felt we could readily rule out a fracture of the skull, and especially one with increased intracranial pressure. We never forgot the possibility of a brain abscess, which would have necessitated a decompression. Major Cyrus Pershing, of Denver, at that time neurologist to U. S. A. Base Hospital No. 29 in London, kindly saw the patient at my invitation, and we agreed on the interpretation of the case as one of severe cerebral concussion.

From a communication I received seven months after I sent the patient home from England, I learned that he had left the Army, that all he had at that time was a dry chronic otitis media; he had some feeling of weakness, and could not ride in subway cars.

TRAUMATIC FACIAL DIPLEGIA*

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One-sided facial palsy is surely of common occurrence. The synchronous involvement of both sides of the face by palsy is exceedingly rare. There is no way of determining the relative frequency of unilateral and bilateral facial paralysis, but in my investigation of the subject I found that many neurologists of large experience have seen no cases at all. As the most common cause of the condition, multiple neuritis easily comes first. In a very excellent article by Patrick,[1] the author added 29 cases, some of his own, and others from literature, to 19 cases previously collected by Laurans,[2] but Patrick believes that quite a number of the earlier cases reported are apocryphal. As I will show, similar doubt applies to cases reported as traumatic.

Facial diplegias have likewise been recorded as a result of diphtheria by Ross, 5 cases, and 4 after influenza. It is evident that quite a number have been reported as the result of double otitis media, and mastoid disease. In a few instances, bilateral so-called rheumatic paralysis of the face has been observed (Bell's palsy). A most interesting case of this nature was reported by Throckmorton,[3] and in which there was an interval of six or seven days between the inception of the paralysis on the two sides.

A very interesting bilateral facial paralysis of syphilitic origin was entirely quoted in French by Sir Charles Bell.[4] It was that of a young woman of sixteen, with a little tumor of the left frontal region. The day after her admission, November, 1828, the left side of the face was completely paralyzed, the tongue a little stiff, and speech embarrassed. The mouth was forcibly drawn to the right side. Eight days after the appearance of the left-sided paralysis, the same symptoms developed on the right side, the tongue was not affected. The eye-lids could not be closed, and the tears welled down on to the cheeks. The lips were flabby, and moved like curtains on expiration. The patient did not suffer in any way. One could hear her in fits of laughter, but she laughed as behind a mask. Under antisyphilitic treatment this patient recovered. I present this case because it is interesting to note that it came from the Hotel Dieu, and the service of Dupuytren, who, sixteen years later, while in the amphitheatre of the hospital, himself suffered from a facial paralysis, which was due to a slight cerebral hemorrhage, that caused his death a year later. The great Cruveilhier made the autopsy.

Peripheral facial paralysis has likewise been observed in infants, as the result of difficult parturition and the use of forceps (Romberg[5]).

The earliest extensive report on facial diplegia appeared in 1901 by Sainton.[6] Of the entire number of cases, only three were said to be of

* Read before American Surgical Association, June 18, 1919.

traumatic origin, namely, those of Gama, Romberg and Koslowski. The cases of Gama and Romberg must be excluded from the traumatic cases, since in neither of them is there any evidence of the involvement of both facial nerves.

By way of digression the case of Gama[7] is interesting, for, according to the patient's statement, two bullets, coming in opposite directions, "whizzed" close to his head. "The shock of these bullets (the patient stated) distinctly struck my ears, and I became unconscious. I was roused from my lethargy by the pain which the Cossacks caused me while robbing me. When I recovered I was entirely devoid of speech, blood flowed from my mouth, from my nose and from my ears, but I recovered. With the rest of the prisoners I traversed Germany, Poland and Russia. There was a profuse bloody discharge from both ears, and this continued for eighteen months, when it finally ceased." Hearing was lost on both sides, but the lips lost none of their mobility. It is evident, therefore, that whatever may have been the primary lesions in this case, and whether or not they were produced by the vibrations of passing bullets, it is impossible to see anything in it like the traumatic paralysis of the portio dura of the seventh nerve.

A similar doubt must be placed upon the quotation from Romberg. The only case of double paralysis which I can find there was that of a man of forty, with a very decided venereal history.

It is probable that in rapidly fatal basal fractures, with general muscular relaxation, facial diplegias occasionally occur, and that they are overlooked because of the difficulty of recognizing them, and the apparent hopelessness of the cases from a prognostic viewpoint. At any rate, I have not seen such cases, nor am I cognizant of any reference to them in the literature at my command. The cases of traumatic facial diplegia are therefore very few. Indeed, I have been enabled to find records of only four. I believe myself justified therefore in giving brief abstracts of these cases.

The case of Koslovsky,[8] then, is the only one of true traumatic facial diplegia which I have been enabled to find reported up to the outbreak of the war, and was reported in 1892.

CASE I. (Dr. B. C. KOSLOVSKY[8]).—Private J. J., while carrying logs from a boat to a landing, fell into the water, a distance about ten feet, and was struck by a log over the left half of the head. When brought into the hospital he was bleeding from both ears and nose and vomiting. Consciousness was retained, but speech was very indistinct. There was a large hematoma on the left side of the scalp. No other external injuries. Considerable headache. Temperature and pulse remained normal. The action of the pupils, negative at first, but later became normal in the right eye. Left pupil was dilated and did not react to light. There was constant and marked diplopia. Hearing very much lessened on the right side, entirely lost on the left. The tuning fork could not be heard on this side. There is complete paralysis of both sides of the face.

All the symptoms detailed appeared simultaneously. After three months the paralysis of the face continued unchanged. The patient remained completely deaf in the left ear, while the hearing in the right was somewhat improved. Taste sense was at no time effected. When the patient was last seen it seemed probable that the condition as detailed at the last examination would be permanent.

Although there was no X-ray confirmation, the diagnosis of basal fracture could not be questioned. The injury to the facial nerves must have been above the geniculate ganglion from the undisturbed taste functions. It is probable that from the involvement of other cranial nerves the tear was above the entrance of the nerve into the internal auditory meatus of each side.

CASE II. (OPPENHEIM and HALLEZ[8]).—P. J., aged 28 years, infantryman, injured October 27, 1916, by the bursting of a large shell in close proximity. There was immediate loss of consciousness, followed by prolonged amnesia. He could furnish no details as to how he was hurt. Consciousness returned sixteen hours later. The primary report states that there were no external lesions. Double facial paralysis, bleeding from both ears, profuse nose bleeding, slight mydriasis on the left side. After a day or two he became semi-conscious again, and when he recovered complained greatly of nausea and vertigo. Epistaxis and bleeding from one ear returned again. He entered the otological service two weeks after his injury for "concussion of the labyrinth, injury to the tympana, with infection on both sides and facial diplegia." The face presents the appearance of a blank mask, without any expression, the creases of the forehead and of the face have completely disappeared, and there is a slight œdema of both cheeks. There is no diplopia, and visual activity is normal. Speech is a little slow, scanning and especially embarrassed by the pronunciation of the labials. Deglutition is normal.

It is interesting to note that after the first visit of the patient's wife, in consequence of a violent emotion, the man presented a complete mutism during four days. The cheeks are flabby, mastication is considerably embarrassed because foodstuffs fall between gums and the cheek. The soft palate is lifted normally, and there is no deflection of the uvula. The sensibility of the tongue is conserved, but the sense of taste is abolished in the anterior two-thirds.

The electrical examination made in January, two months after the injury, shows a degeneration reaction of the seventh pair, a little more marked on the right than on the left side. The hearing on the right side is diminished, and there is an otitis media. On the left side hearing is quite gone, and there is suppuration of the middle ear. The facial and auditory nerves seem therefore to have been involved, but no others are in any way injured.

The lumbar puncture made in January showed a clear lymphoid fluid, with a little more albumin than normal, and a scarcely appreciable increase of cellular contents. During the months' sojourn in the service, the patient improved considerably, the eyelids could be partially closed, and the forehead slightly furrowed. As to the cause of the paralysis, the authors are in doubt. It might have resulted from a fracture through the petrous portion of both temporal bones, or it may have resulted from an immediate intratubal concussion. It is possible also that the injured man was thrown backwards and sustained a fracture of the base, through-both temporal bones. In favor of this hypothesis are the nose-bleed, the repeated bleeding from the ears and the prolonged coma. In support of the possibility of the shock of the explosion alone causing the damage in the petrous portions of the temporal bones without fracture, the authors allude to two men, who, without any trace of external injury, or even of a fall, presented, as a result simply of concussion, a total unilateral facial palsy.

CASE III. (CHATELIN and PATRIKIOS[30]).—The case, when presented, was one of six weeks' duration. There was a total double paralysis of the peripheral type. On the left side the paralysis is absolute, while on the right there is an indication of very slight movement, in an effort to close the eye. The aspect of the face is characteristic. The forehead is entirely without wrinkles, naso-labial folds have disappeared, the lips are half open, and the saliva drools from the mouth. Speech is almost incomprehensible. Mastication is very difficult. Electrical examination shows complete reaction degeneration on both sides. The diplegia was the result of an accident. The wounded man was about to unload a heavily loaded wagon, when it was suddenly propelled backwards

and his head was caught transversely between the wall and the wagon. Released at once the man bled from the left ear. The diplegia manifested itself at once. For several days the face was very much swollen, and he had many ecchymoses in the temporo-malar region. Eating was uncomfortable on account of the trismus. This, however, disappeared in a few days. The writer believes that the facial nerve was injured on both sides by a transverse fracture at the base of the skull, even if there were no actual symptoms of injured lesions of the organ of audition. It appears to the writer that in the absence of loss of taste and of the radiographic evidence of fracture of the base, in this case, it is more likely that underneath the ecchymoses described in the temporo-malar region, the facial nerves had been injured by compression after their exit from the stylo-mastoid foramen.

CASE IV. (L. MARCHAND[11]).—Soldier, 22 years old, was thrown from an automobile truck on August 22, 1917. He has no recollection of how the accident occurred. There is immediate bleeding from both ears, epistaxis and bilateral facial paralysis. In the temporal region there is a contused wound.

The patient was unconscious for forty-eight hours.

Diagnosis.—Fracture of the base of the skull. On the morning following admission there was a considerable palpebral and subconjunctival hematoma; there was also a hematoma at the nape of the neck. A lumbar puncture was made on the day of the accident, but in the original report no result of the examination is given. During six days the punctures were repeated. He was admitted to the Neurological Center of Bordeaux, on the 4th of December, 1917, when the facial paralysis continued. The record states that the movements of the face are nil on both sides. The patient cannot laugh, cry or whistle. Speech is difficult, on account of the inability to pronounce the letters B, P and M. Swallowing is normal, but to drink the patient must hold his head backwards to prevent the liquids from running out of his mouth. The sense of touch and pain is normal, both in the tongue and the face. Salt, acids and sweets are not felt in the anterior two-thirds of the tongue on the right side, but the taste for bitter things is normal on both sides. In March, of 1918, there was some voluntary movement of the lower portion of the left side, and the left eye could be completely closed. There was still a loss of gustatory sense on the left side. On the right side the paralysis presents no improvement.

The following is the one I have been privileged to observe:

CASE V.—Miss E. K., aged twenty-two years, injured January 4, 1919, in a street-car accident. On entering the First Surgical Service at the Cincinnati General Hospital she was unconscious and bleeding from both ears. The coma, which was not deep, continued for over an hour, and was followed by vomiting. There were two general convulsions, lasting for about five minutes. Both convulsions were preceded by twitching of the right eye-lid, and the entire half of that side of the face. During ten days following the accident the patient suffered from severe headaches, with pain in the ear and nausea. Pulse on entrance varied betwen 82 and 90, and was of good quality. The temperature was normal.

On admission there was a slight contusion in the right frontal region, and an incised wound 5 cm. long in the midline. There was a complete left-sided facial paralysis, and a slight ecchymosis on both mastoid regions.

On the morning of the third day after admission, the right side of the face was found to be completely paralyzed. The neurological ex-

amination at this time by Dr. Hoppe shows that the patient was oriented for time and place. The facial expression is one of indifference, and there is a decided mental sluggishness. The right pupil is slightly larger than the left, and the left external rectus a little weak. All other eye muscles are normal. The paralysis of the face is complete, the patient being unable to close either eye in the slightest, to move her lips or the wings of the nose. The face is mask-like, and the lips flap loosely on expiration. Owing to the inability of using the lips, speech is very indistinct. Facial expression which would result from an emotion is only expressed by the eyes.

Ear examination by Dr. Iglauer shows tinnitus in the right ear. Both drums are intact, there is no spontaneous nystagmus. Weber to the left. Bone conduction is normal. Whispered voice is heard at 8 feet in both ears. A lesion of the eighth nerve on either side can therefore be excluded. There is no hyperacousis.

An examination of the tongue shows that it can be protruded normally, in the middle line, and moved from side to side. There is no deflection of the uvula. The sense of touch is normal. The gustatory sense is completely absent on both sides of the anterior two-thirds of the tongue. The patient is unable to taste sweet, vinegar, sugar or bitter things.

The X-ray examination and the stereoscopic plates show an oblique fracture through the cranial base, running through the left mastoid process into the petrous portion of the temporal bone.

According to the subsequent history the paralysis disappeared from the right side of the face in the course of two or three weeks, and during the next two months it had disappeared entirely from the left side. The muscular control returned first in the lower part of the face. First, a slight motion of the angle of the mouth, then of the nose and lastly of the eye-lids. This progress of recovery occurred upon both sides. It is interesting to note that the presence of a partial paralysis and the manner of retrogression of a paralysis may be explained on the theory advanced by M. Moure, namely, that the facial nerve in the Fallopian canal is composed of two sets of fibres—the one peripheric or superficial, which constitutes further along the supply of the lower facial group of muscles, the other central or deep, and which innervates the upper muscle group. The superficial fibres would, therefore, be more exposed than the deeper ones to irritation and compression coming from the outside, and, therefore, there would be a slower return of the muscular power in the lower facial area. So far as I know, there has been no anatomic demonstration of this theory. In fact, the case reported substantially contravenes the hypothesis as set forth. The same lack of confirmation is made manifest by the case of M. Marchand. Nevertheless, the anatomic question is one of exceeding interest, and would well merit further study.

An interesting point is that in this patient there were two convulsions, each beginning with twitching of the right side of the face. This might lead to the belief that there had been some irritative lesion

of the right nerve in the canal before the hemorrhage had set in. The slight weakness of the left external rectus could not be accounted for, and disappeared very rapidly.

Remarks.—It is very evident that the lesion in this case, on each side, was in the Fallopian canal, below the geniculate ganglion, and at a point above where the chorda tympani is given off. It was also below the point where the nerve to the stapedius is given off, since there is no record of hyperacousis.

Although there was a fracture across the base of the skull, through the mastoid and petrous portion of the temporal bones, as shown by the ecchymosis behind the ear, it is quite certain that neither nerve was severed. Of the right nerve one can be sure of this, since the paralysis did not manifest itself until two days after the injury. Hemorrhage only could have accounted for this late occurrence. On the left side the paralysis was instantaneous, but since it completely and speedily recovered, it is likely that here also there was only a contusion with hemorrhage. Where there has been a complete severance in continuity, recovery after fracture is very uncommon, and if it does occur, does so only after the lapse of many months.

It is evident from the above that traumatic facial diplegia is an exceedingly rare condition, since I have been enabled to get only four other cases from the literature at my command. It is remarkable that all of these cases recovered, since, with the possible exception of two of the cases, all of them presented evidences of basal fracture, and in one of these the basal fracture could not be positively excluded. In Case II, there is a possibility that the peripheral portions of the nerve, after their exit from the stylomastoid foramina, were injured, since there was no record of the loss of taste.

In none of the cases recorded was a decompressive operation indicated in the judgment of the surgeons in charge. With the exception of one of the cases, on each side the lesion was in the Fallopian canal, although in our case hearing was not involved, whereas in some of the cases it is evident that from the loss of hearing the eighth nerve was included in the damage, either as a result of hemorrhage or of concussion of the internal ear.

Since the above was written, I have received a communication from Dr. Ernest Sachs, who reports the following case of traumatic facial diplegia from the Barnes Hospital.

Case VI.—The patient, aged sixteen, was admitted October 11, 1912. Motorcycle accident. There was bleeding from the right ear and the nose. No fracture could be made out by palpation. K. K. very active. No ankle clonus, and no Babinksi reflexes present. The left eye somewhat dilated. Does not respond to light. Slight exophthalmos of the left eye. Pulse 138. Blood-pressure 135. Vessels in the eye grounds are tortuous. Lumbar puncture could not be made. There is complete external rectus paralysis on the right side and a slighter one on the left. The orbicular muscle about the mouth cannot be used. He is unable to pucker his lips, nor can he whistle. It is evident that there is a bilateral facial involvement. Neither facial nerve reacts to

faradism, and it is only with the strongest possible current that one can get contractions. Does not seem to taste quinine on the anterior part of the tongue, but does on the posterior. Salt and sugar are both recognized. When the patient sleeps, both eyes are completely closed, while when awake and told to close them he cannot do so. X-ray plates do not show a basal fracture. Just before the patient was discharged on the 11th of October, it was noted for the first time that he was beginning to gain some use of the muscles about the mouth on the left side.

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A CLINICAL STUDY OF NERVE ANASTOMOSIS *

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This paper represents the results of forty-one cases of nerve anastomoses performed in the Mayo Clinic up to January 1, 1917. Cases in which post-operative records are shorter than sixteen months are not included in the report.

In 1852 two theories of nerve regeneration were advanced; one, that the axons grow out from the central end, that complete degeneration takes place from the severance of the nerve proximal to the node of Ranvier, and distally through the entire peripheral nerve; and two, that the axons do not degenerate in the peripheral stump after they have been separated, and that the fusion with the central axon and the development of the new myelin sheath about it is necessary to enable an axon to functionate.

The modern work on the regeneration of nerves may be said to have been begun by von Büngner in 1891, followed by Howell and Huber in 1892, by Ströbe in 1893, and by Huber in 1895. Von Büngner called attention to the nucleated protoplasmic bands which have been so conspicuous in the histogenesis of regenerated nerve fibres. He emphasized the fact that the nuclei of the neurolemma increase in number and that the protoplasm accumulates about them. Howell and Huber observed the presence of protoplasmic bands (Bandfäsern) but regarded them as embryonic nerve fibres capable of receiving and transmitting impulses. Ströbe was able to demonstrate the outgrowth of axons from the central end but believed that the myelin sheath was formed as a continuation of the old sheath. Huber, working with Ströbe's technic, was able to show that the axons grew from the central stump and in some cases entered the substance of the protoplasmic bands in the distal segment. Ranson in 1912 presented his work on the degeneration and regeneration of nerve fibres, in which he verified the investigations made by Waller in 1852, and gave a clear description of the processes of degeneration and regeneration, as well as a thorough review of the literature. Kirk and Lewis in 1915 and 1916 also presented a very complete histologic study of nerve regeneration.

Nerve anastomoses have been accomplished by the use of methods as follows: Létiévant made flaps from the central or the peripheral stump of the divided nerve, or from both the central and peripheral stumps. If it was impossible to bring about an immediate approximation of the

* This material was studied in the preparation of a thesis submitted to the Graduate Faculty of the University of Minnesota in partial fulfilment of the requirements for the Degree of Master of Science in Surgery, June, 1918.

nerve ends, various materials were used to bridge the gap. Assaky recommended a bridge of catgut between the severed ends, Vanlair used decalcified bone tubes, Payr magnesium tubes, Forssman celluloid tubes, Lotheissen gelatin tubes, Foramitti the hardened arteries of the calf; Denk, Döpfner, Kredel, and Kirk and Lewis fascia lata tubulization, Corbett and Beckman vein tubulization, Sherren Cargile membranes, Auerbach galalith, and Assaky and Hubner nerve transplants. Feiss used the fusion method of overlapping the ends and ligating them with silk or chromic catgut.

All of the various methods of nerve anastomosis have been discarded except: (1) the flap method, (2) the fusion method, (3) fascial tubulization, (4) vein tubulization, (5) Cargile membrane tubulization, (6) nerve transplantation, and (7) end-to-end anastomosis.

The nerve flap method, described by Létiévant, has been used extensively by operators in general surgery. Their patients improve, but the degree of improvement is not accurately stated in their reports.

The fusion method was advocated and tried out experimentally by Feiss, who felt that regeneration depended more on the regenerating scar than on the approximation of the nerve ends.

Fascial tubulization was brought to our attention recently by Kirk and Lewis, who presented a study on experimental tubulizations as well as reports of clinical tubulizations. However, the fascia lata had been used by former workers, for example, Denk, Döpfner, and Kredel.

Vein tubulization was described by Corbett, who employed very much the same technic that Kirk and Lewis used in their fascial tubulization, namely, removing a large portion of vein, dividing it longitudinally and placing it around the severed ends of the nerve as a piece of fascia. Beckman used the resected vein as a closed tube, slipping the cuff of vein over one of the nerve ends prior to anastomosis and then bringing the vein back over the intervening gap, and surrounding the cylinder of silk.

Sherren recommended the use of Cargile membranes, the fixed peritoneal membranes of the ox, for the purpose of tubulization.

Nerve transplants were suggested and tried experimentally by Philippeaux and Vulpian. They were used by Assaky in clinical cases and by Huber in a series of experimental cases. Huber reports twenty-six experiments made on the foreleg nerves of dogs. Ten were observed for a period of time long enough to permit regeneration of the peripheral stump, five of which presented complete and four nearly complete return of function.

It is rather difficult to classify the results of the various operations reported in the literature on the subject. Speiser in 1902 collected 208 cases of nerve suture; these combined with 129 cases collected by Schmidt make 337. Two hundred and thirty-four patients (66.5 per cent.) obtained good results, 53 (15.5 per cent.) obtained partial relief, while 60 (18 per cent.) were not improved by the operation.

Sherren reported 4 (50 per cent.) successful cases in 8, by the autotransplant and homotransplant methods, and Huber reported 37 per cent. of successes in 22 cases of heterotransplants.

Oberndörffer reported 167 cases of nerve sutures, in 96 of which operations were done the day after the injury. Good results were obtained in 38 per cent., fair results in 35 per cent., and failures in 16 per cent.; the results in 11 per cent. were unknown. In cases in which operations were done from two to seven days after the injury, good results were obtained in 35 per cent. and fair results in 52 per cent.; the results were unknown in 15 per cent. In the operations done from eight to fourteen days after the injury good results were obtained in 57 per cent. and fair results in 43 per cent. In operations from three to four weeks after the injury good results were obtained in 56 per cent., fair results in 32 per cent. and failures in 12 per cent. In operations from five to eight weeks after the injury good results were obtained in 44 per cent., fair results in 25 per cent., and no improvement in 31 per cent. The statistics with regard to nerve suture, compiled by different men, show that good results were obtained in 70 per cent. of the cases.

HISTOLOGY

A brief review of the histology of peripheral nerves will call attention to the fact that the fibres of medullated nerves arise from the anterior horn cells and join the fibres from the dorsal root which contains both medullated and non-medullated fibres (Ranson). The non-medullated nerve fibres have their origin in small ganglion cells in the dorsal ganglion, and have axons surrounded by a neurolemma without myelin. The medullated nerve fibres have an axilemma next to the axis cylinder; this is surrounded by the myelin sheath, which in turn is surrounded by a neurolemma (Schwann's sheath). The myelin is divided into segments by the nodes of Ranvier. Elongated cells which are of the utmost importance during the process of regeneration are associated with Schwann's sheath.

Degeneration and Regeneration.—Immediately following the division of the nerve, abortive regenerative processes take place; that is, the axis cylinder in both the proximal and distal stumps (more pronounced in the proximal end) undergoes fibrillar disintegration with an outgrowth of fibrillæ within the neurolemma. This process extends back for a distance of about three millimetres and begins within the first thirty-six to seventy-two hours following the severance of the nerve. At the same time the nuclei associated with the Schwann's sheath start a process of hyperplasia which begins with enlargement of the nucleus and a granular deposit in the cytoplasm. The wallerian degeneration begins about the third day and is quite complete on the twelfth day, except for the resistant axons and the myelin granules that may be seen for several weeks. This process consists of a granular disintegration of the axon in the distal end

and of the axon in the proximal end up to the first node of Ranvier. The myelin begins to disintegrate and forms droplets of fat within the neurolemma, thus giving a positive black stain with Marchi's method, whereas the normal myelin gives a yellow stain.

The regenerative process is continuous with the degenerative process; first, the nuclei of Schwann's sheath multiply very rapidly and fill the empty lumen of the neurolemmal sheath in the distal end as well as the sheaths from the site of severance to the first node of Ranvier; then, if the intervening gap between the severed ends is not too long, or if it is protected by some form of tube, these cells will send out protoplasmic bands of gelatinous appearance, which fill the intervening gap. Simultaneously the axon sends out numerous neurofibrillæ, numbering from five to fifteen, which grow downward through the mass of protoplasmic bands, and, if the gap has been bridged by these bands, they follow the bridge and enter the distal nerve segment. It is not uncommon to find two or three axons following a single protoplasmic band. Many of the neuraxons, however, will fail to enter the distal nerve segment and will produce an oval enlargement at the site of anastomosis, known as a neuroma.

The protoplasmic bands and cells arising from the neurolemmal sheath not only assist in keeping the lumen of the distal segment open and bridge the intervening gap between the nerve ends, but also apparently they arrange themselves and act as a reticulum, forming the mesh work in which the myelin is deposited, enabling the nerve to complete its process of regeneration. The following outline is quoted from S. Walter Ranson:

"*Early Changes in the Distal Stump.*—1. Degeneration of the medullated fibres and formation of nucleated protoplasmic bands. 2. Degeneration of the non-medullated fibres and the formation of nucleated protoplasmic bands. 3. Abortive autogenous regeneration in the distal stump.

"*Early Changes in the Proximal Stump.*—1. Changes in the non-medullated fibres; early abortive regeneration; cellulipetal degeneration; formation of new axons. 2. Changes in the medullated fibres; formation of a zone of reaction; fibrillar dissociation; early branching of the axons in the immediate neighborhood of the lesion; formation of lateral branches at some distance above the lesion; formation of fibre bundles and skeins.

"*Mechanism of the Regeneration of Nerve Fibres.*—1. Proliferation of axons in the central stump. 2. Penetration of the new axons through the scar. 3. Utilization of the protoplasmic bands as pathways for the new axons in the distal stump."

CLINICAL FINDINGS

All the patients had preoperative neurologic examinations, and many returned for subsequent examinations. We secured data of the patients, who were unable to return, by correspondence and by the coöperation of local physicians.

Nine facial anastomoses were made (five females and four males). The average age of the patients was twenty-four years. Eight (89 per cent.) of the nine patients have been examined at intervals following operation, or they have reported by letter. The average duration of the injury before the anastomosis was made was twenty-six months. The three patients who were operated on within the first year following the injury showed improvement of from 60 to 85 per cent. in return of function. The patients operated on at varying periods of time up to five years showed an improvement up to 50 per cent. of function. One patient, with a fifteen year history, failed to reply to the " follow-up " letter. The injury of the nerve in two cases was due to a mastoid operation and in seven cases to a lacerated wound in the region of the seventh nerve. In eight cases the anastomosis was to the spinal accessory, in one case to the hypoglossal. In eight cases end-to-end anastomoses were made, three of which were covered with fascia, four with vein, and one was left uncovered. In one case the anastomosis was by the Feiss method, the nerve ends were overlapped and ligated with silk. The average time before improvement was noticed, following the anastomosis, was seven and nine-tenths months; the average time for maximum improvement to be reached was eighteen and one-half months. The average amount of motor return estimated by quantitative examination of the power and control of the facial muscles, was 71 per cent. of the normal function.

In summing up the results, it is found that in 89 per cent. of the patients heard from, all of whom had improved, the average amount of improvement was 71 per cent., and in this group there were no failures nor indeterminate results, no infections and no deaths.

Seven ulnar anastomoses (one female and six males) were made. The average age of these patients was twenty and four-tenths years. Five (71 per cent.) were heard from or were studied following operation. The average duration of the injury before the anastomosis was six months, the shortest six weeks, and the longest twelve months. Two of the injuries were associated with fractures of the elbow and two with lacerated wounds of the forearm. Six of the anastomoses were made with silk sutures and one with chromic catgut. Three were covered with fascia. In five cases the apposition was direct, without a gap; in two the gap, which was an inch long, was covered with a tube of fascia lata. The average time before improvement was noticed in these cases was ten months; the average time before maximum improvement was noted was sixteen and two-tenths months. The amount of maximum improvement in the patients who reported was 63 per cent. of the sensory, motor, and trophic functions. There were no failures nor indeterminate results, no infections, and no deaths.

One radial anastomosis was made. The patient, a man aged twenty-four years, was operated on two months after the injury. The anasto-

mosis was done with silk. Unfortunately, we have not been able to obtain a report from this patient since he left the clinic.

Seven median nerves were repaired. All the patients were males, their average age was twenty-three years. Six (85.7 per cent.) of these patients have been heard from, or have been studied following operation. The average duration of the injury before operation was eighteen months, the shortest six weeks, the longest four years. Five patients were operated on within the first year, two gave a four-year history; all the injuries were due to lacerated wounds. In three cases the anastomoses were made with silk, in three with chromic catgut, and in one a plastic operation was done. In five fascia covering was used, in two the nerve was left uncovered. Direct apposition was obtained in five cases; in two a gap of one inch separated the severed ends. The average time

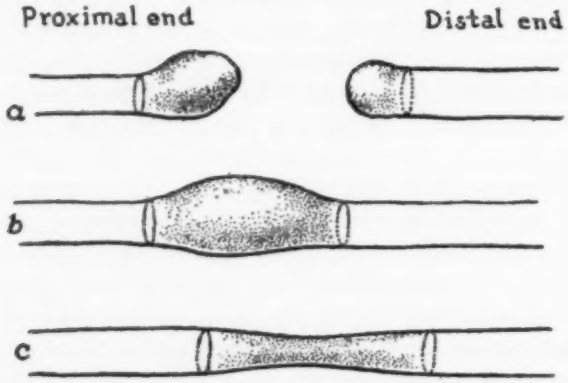

FIG. 1.—Clinical findings in peripheral nerve injuries, (a) severed nerve with neuromas and lines indicating the level of resection prior to anastomosis, (b) neuroma due to trauma without severance of the nerve, (c) constriction of nerve due to scar tissue or callus.

before improvement was noticed was ten and nine-tenths months, the average time before maximum improvement was reached was twenty-one months, with 72 per cent. return of the sensory, motor, and trophic functions. There was, therefore, in the patients heard from, improvement in 71 per cent., one failure, no indeterminate results, no infections, and no deaths.

Ten musculospiral anastomoses were done; all the patients were males, whose average age was thirty-six years. Nine (90 per cent.) were heard from after operation. The average duration of injury was twenty-eight months, the shortest two and one-half months, the longest twelve years. Nine of these injuries were associated with fractures of the humerus; one was due to a lacerated wound. Seven of the anastomoses were end-to-end, with silk and chromic catgut sutures. In two the operations were plastic; a segment of the proximal end was turned down. In one case the nerve was freed from adhesions. In seven cases the anastomoses were covered with fascial tubes; in four of these a gap of from one-half to one and one-half inches separated the ends of the nerves. The average time before improvement was noticed was twelve months; the

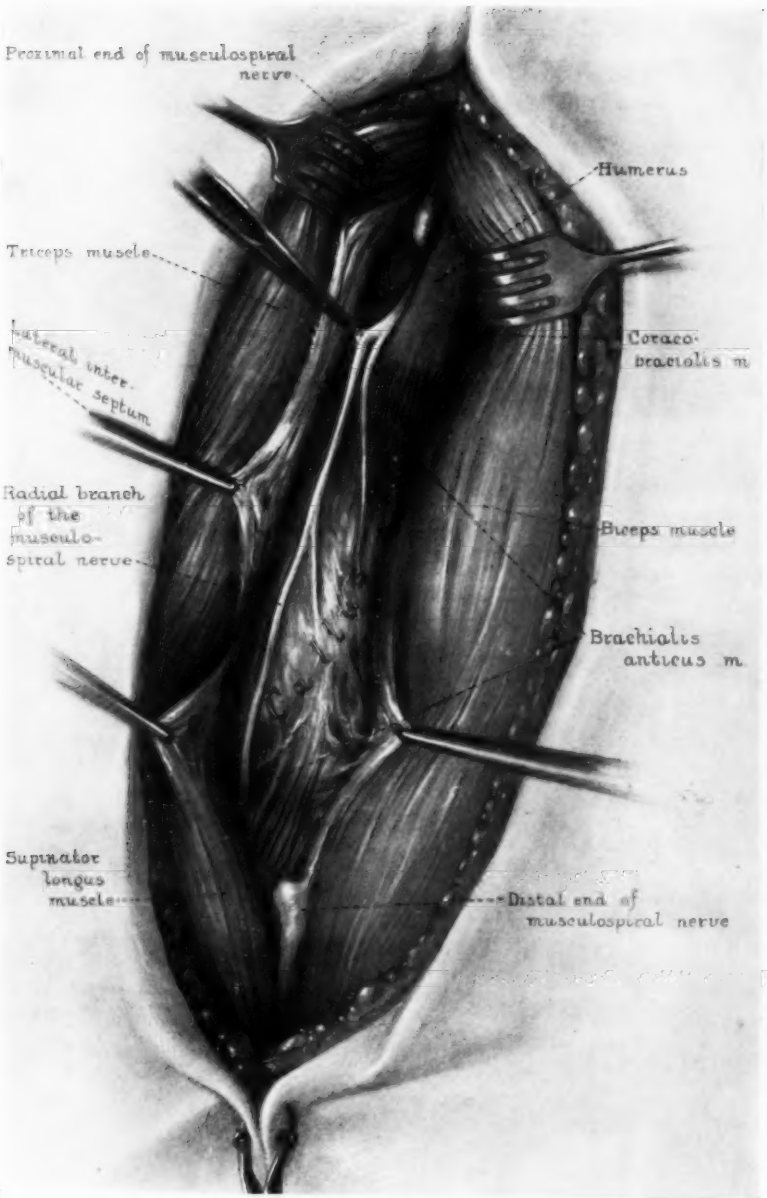

FIG. 2.—Anatomic relations of the proximal and distal neuromas of the musculospiral nerve, following complete severance at the time of fracture of the humerus.

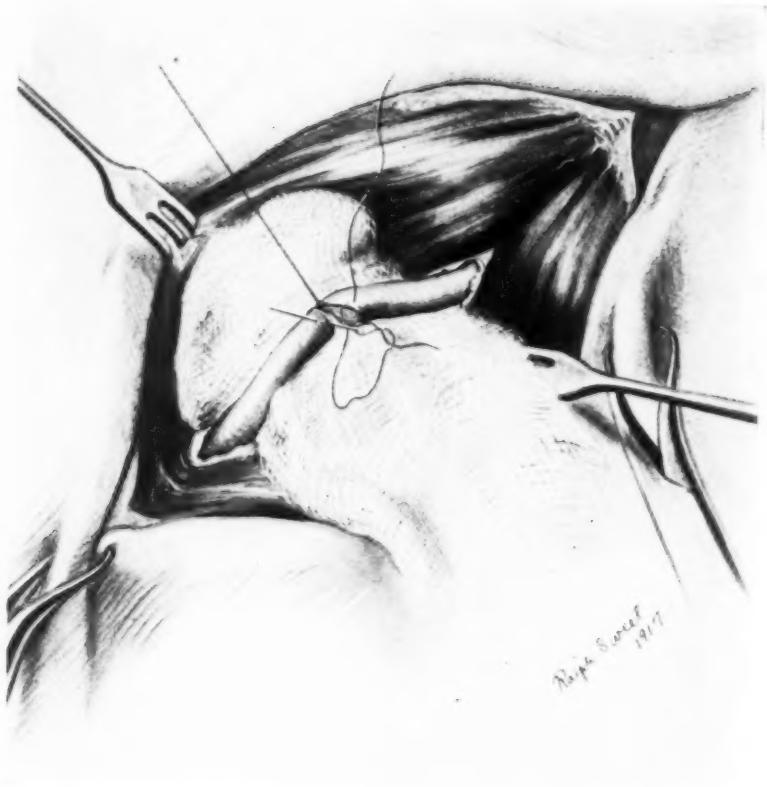

FIG. 3.—Anastomosis of the musculospiral nerve with silk. Stitches placed in the epineurium.

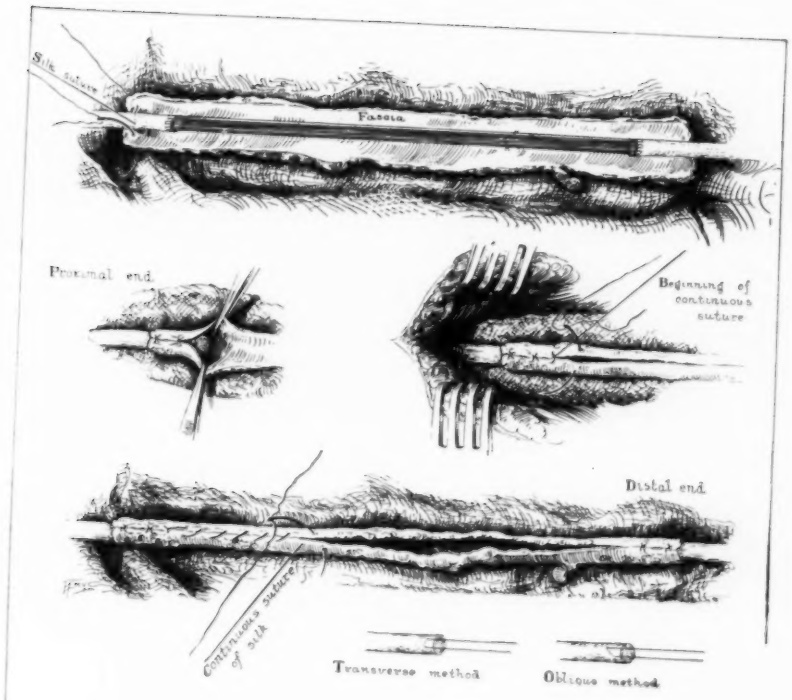

FIG. 4.—Method of anastomosis with silk and fascia. Various steps shown, in the covering of the cylinder of silk with fascia.

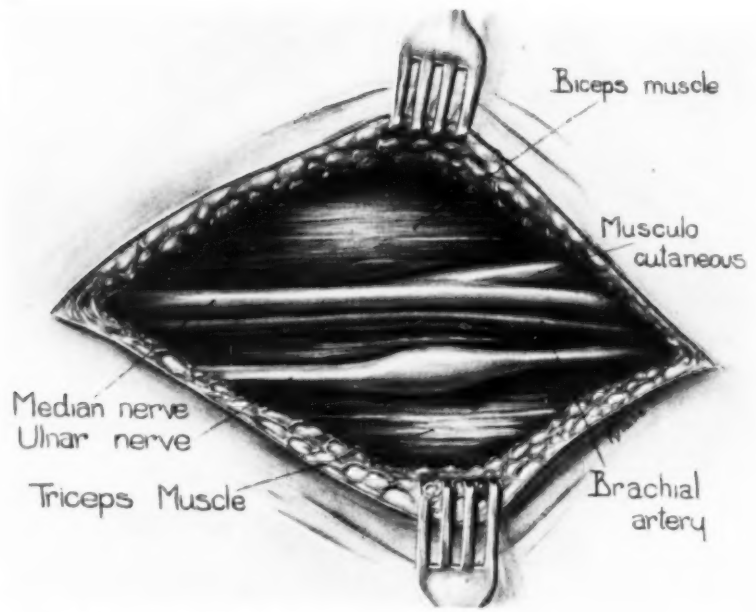

FIG. 5.—(202189) Exposure of the ulnar nerve in the right upper brachial region with a large neuroma due to trauma, without severance of the nerve.

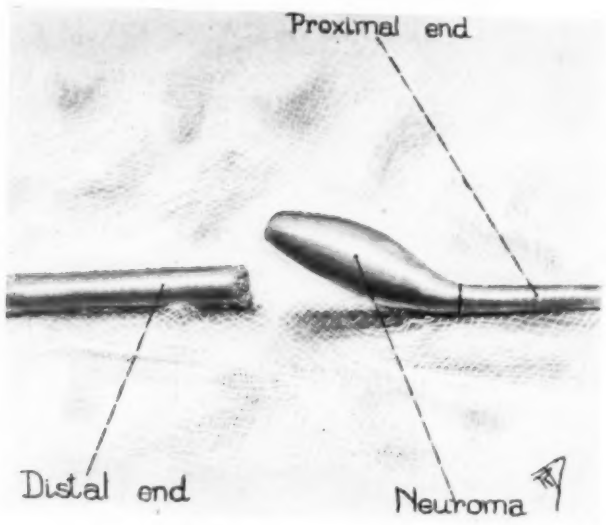

FIG. 6.—(202189) Resection of neuroma previous to anastomosis.

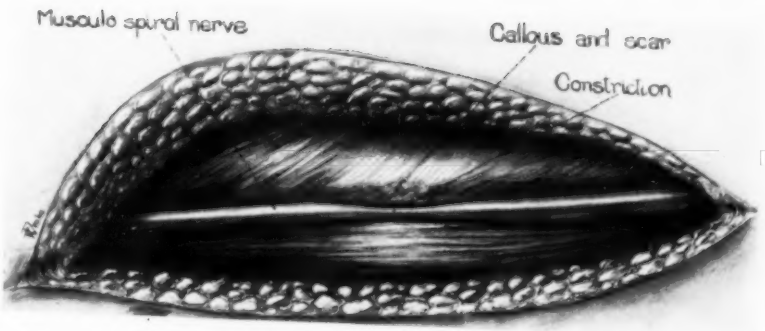

FIG. 7.—Exposure of the left musculospiral nerve, constricted by an exuberant callus and scar, without complete destruction.

FIG. 8.—Covering the constricted musculospiral nerve with a facial flap to avoid further constriction.

FIG. 9.—Anastomosis of the proximal end of the spinal accessory nerve to the distal end of the seventh nerve.

average time before maximum improvement was noted was twenty-seven months. The amount of improvement in the patients benefited was 72 per cent. of the sensory, motor, and trophic functions. Twenty per cent. only of these patients were improved, in 30 per cent. the results were indeterminate, and in 50 per cent. they were failures. In one patient the wound became infected. There were no deaths.

Four external popliteal anastomoses were made, all on males, whose average age was thirty years; all have been heard from following operation. The average duration of injury was twelve months, the shortest eleven months, and the longest sixteen months. Three of the injuries were associated with lacerated wounds, and one with dislocation of the fibula. Three of the operations were end-to-end anastomoses with silk and were covered with fascia, while the fourth was a plastic operation. The average time before improvement was noticed was eleven months; the average time before maximum improvement was reached was approximately twenty-four months. The average improvement obtained was 43 per cent. return of the sensory, 30 per cent. of the motor, and 80 per cent. of trophic function. In one case the result was a failure, and in another the result was indefinite. The failure of regeneration in one case was due to an infection in the wound.

Two sciatic nerves were repaired. One patient was injured eight years before coming to the clinic; the time the other was injured was not ascertained. The injury in one instance was due to a revolver bullet, in the other to a lacerated wound. Both operations were end-to-end anastomoses, one with silk and one with chromic catgut; fascia was used for covering in both cases. In the one case there was a gap of three-fourths of an inch between the nerve ends. The average time before improvement was noticed was six months; the average time until maximum improvement was reached was eighteen months. One of the two patients was heard from following operation; he reported 40 per cent. return of the sensory, motor, and trophic functions.

One right recurrent laryngeal was anastomosed end-to-end, one year after the injury. The patient was a male, aged thirty-nine years. The suture material used was not recorded. Improvement was first noticed twelve months after the operation; maximum improvement, 90 per cent. return of the motor function, was reached at the end of thirty-six months.

GENERAL SUMMARY OF CLINICAL FINDINGS

Of the forty-one patients operated on for nerve anastomosis, thirty-five were males and six were females. The average duration of injury was fifteen months. Seventy-three per cent. of the patients have been under observation or have been heard from since the operation. Seven of the forty-one injuries were associated with fractures, one with a dislocated bone, and thirty-three with lacerated wounds. Eighty and five-

tenths per cent. of the operations were end-to-end anastomoses; the balance (19.5 per cent.) were plastic operations of some sort. Sixty-five per cent. of the forty-one anastomoses were sutured with silk, 29 per cent. with chromic catgut. Fascia alone or with silk and chromic catgut in the form of a tube was used to protect the anastomosis in 49 per cent., vein was used in 10 per cent., and in 10 per cent. there was no covering. Seventy-three per cent. of the anastomoses were in direct apposition, 27 per cent. presented gaps varying from one-half to one and one-half inches in length, the average length being one inch. The average time before improvement was noticed was nine and nine-tenths months and the average time to reach maximum improvement was twenty-one and five-tenths months. The average amount of improvement obtained was 58 per cent. return of the sensory, 62 per cent. return of the motor, and 67 per cent. return of the trophic function. Seventy-three and one-tenth per cent. of all the patients operated on showed improvement, 17 per cent. of the operations were total failures, and 9.7 per cent. gave indefinite results. Four and eight-tenths per cent. of all the wounds became infected. There were no operative deaths.

OPERATIVE FINDINGS

Three clinical conditions may be found at operation:

1. Complete severance of the nerve with retraction, and a neuroma on each end. The neuroma on the proximal end is usually about twice the normal size of the nerve, while the neuroma on the distal end is very small, only about one and one-fifth times the size of the normal nerve. The portion of the nerve below the distal neuroma is enlarged to about one and one-sixth times the normal size of the nerve; it is œdematous and injected, and has a rather soft, mushy feel.

2. A diffuse and nodular thickening of the nerve, due to trauma. This occurs usually over some bony prominence; for example, a very common lesion is that found in the ulnar nerve, where it is situated over the inner condyle of the humerus, the anterior tibial, which passes around the head of the fibula. The proximal end of the nerve is normal in appearance and size, while the distal end is enlarged, œdematous and injected; the enlargement is about one and one-sixth times the size of a normal nerve. The nodular masses are pseudoneuromas and histologically show an interstitial neuritis.

3. A condition due to constriction of the nerve, the most common example being the musculospiral nerve, which is strangulated by the callus which forms after a fracture of the humerus. The histories in such cases are very significant in that the paralysis is progressive and comes on several weeks after the injury. The nerve proximal to the constriction is normal in appearance and size, while the portion distal to the constriction is frequently smaller than the normal nerve and not œdema-

tous nor injected unless the constriction is complete, when the appearance is the same as in the second group.

Paralysis of the seventh nerve may be caused by inflammatory processes or trauma; in either case surgery is indicated unless there is a spontaneous cure.

OPERATIVE TREATMENT

The ends of a severed nerve are retracted, generally, in the line of its original position. The ends are usually adherent to the mass of scar tissue, so it is quite important to expose normal nerve above and below the scar, after which the ends should be freed by very gentle dissection. After the neuromas have been exposed all of the neuromatous scar tissue should be removed. The bleeding is usually controlled by allowing the cut ends of the nerve to come in contact with dry sponges for from five to ten minutes. If this is not sufficient, the vessel may be tied with fine catgut.

In anastomosing nerves the sutures are applied to the sheath (epineurium) surrounding the nerve. They are inserted obliquely into the sheath, thus bridging the gap with a cylinder of silk, of five or six strands, to the nerve. If the ends can be brought into apposition, no fascial covering is necessary. If there is much tension, fine silk is preferable to chromic catgut for suture material. When it becomes necessary to leave a gap between the nerve ends it is important that this gap should be covered by membrane or fascia. An apposition is preferable to a gap, as the prognosis is much better. It should be remembered that a nerve will stand gentle stretching and that the extremities may be flexed to relieve tension.

The surgical procedure in a traumatized nerve with neuroma depends on the amount of existing paralysis. If the paralysis is less than 50 per cent., the epineurium and perineurium are divided to liberate the normal nerve fibres, but if the paralysis is more than 50 per cent. the neuroma is resected, exposing normal nerve fibres above and the definite nerve sheaths below; the ends are anastomosed in the same manner as when the nerve has been completely severed. This distinction is made on the grounds that if there is 50 per cent. function and further paralysis can be prevented, it is much better that the patient should be slightly handicapped than that the nerve should be resected and anastomsed with the chances of failure.

The surgical treatment of constricted nerves also depends on the amount of paralysis present. If the paralysis is less than 50 per cent., the nerve is freed from the surrounding scar tissue and protected by a cuff of fat and fascia. If the paralysis is more than 50 per cent., the constricted area is resected and anastomosed.

The surgical treatment of facial paralysis depends on the cause of the lesion, and it is better to wait a reasonable length of time after the injury (six months) before advising operative treatment, unless it can be deter-

GENERAL SUMMARY OF OPERATIVE RESULTS.

Results of Improvement in Per Cent.

Nerves operated on	Number of operations	Average age	Males	Females	Single	Married	Average duration of injury (months)	Cause of injury	Silk sutures	Chromic sutures	Fascial covering	Vein covering	No covering	Plastic flaps	Freed from adhesions	Gap	Distance in inches	No gap	Time improvement began (months)	Time of maximum improvement (months)	Types of improvement, per cent. Sensory	Motor	Trophic	Improved	Indeterminate	Failures	Patients not heard from	Wound infections	Mortality	Remarks
Facial	9	24	4	5	4	5	26	2 following mastoid operation 7 following trauma	6	0	..	4	2	2	1	0	0	9	8	19	..	71	..	89	0	0	11	0	0	Longest injury 15 years not heard from
Ulnar	7	20	6	1	7	0	6	2 associated with fracture of the elbow 5 associated with lacerated wounds	4	1	3	0	0	0	0	2	1	..	10	16	63	63	63	71	0	0	29	0	0	
Radial	1	24	1	0	1	0	2	1 lacerated wound	0	.	0	0	..	1	0	?	...	..	..	..	..	..	..	..	..	..	100	0	0	
Median	7	23	7	0	6	1	18	7 lacerated wounds	5	3	5	..	2	1	0	2	1	..	11	21	72	72	72	72	0	14	14	0	0	2 cases reported (1 inch each)
Musculospiral	10	36	10	0	3	7	28	9 associated with fracture of the humerus 1 lacerated wound	7	7	7	..	..	2	1	4	1½	..	12	27	72	72	72	20	30	50	10	10	0	Longest gap 1½ inches not heard from
External popliteal	4	30	4	0	2	2	12	1 associated with dislocated fibula 3 lacerated wounds	3	0	3	..	..	1	0	2	(1) 3 (2) ¾	..	11	24	43	30	80	50	25	25	0	25	0	Longest gap became infected
Sciatic	2	22	2	0	2	0	(1) 96	2 lacerated wounds	1	1	2	..	..	..	0	1	(1) ¾	..	6	18?	40	40	40	50	0	0	50	0	0	Case 8 years' duration partly improved
Right recurrent laryngeal	1	39	1	0	0	1	(1) 12	1 following thyroidectomy	1	0	0	0	0	0	0	0	0	1	12	36	..	90	..	100	0	0	0	0	0	
Totals	41	..	35	6	25	16	.....	.....	27	12	20	4	4	7	2	11	.....	..	..	..	..	..	..	..	..	..	..	..	..	
Averages	..	28	..	..	..	..	15	.....	..	..	..	..	..	..	..	..	.....	..	10	22	..	..	..	..	..	..	..	..	..	
Per cent	..	..	..	..	..	..	.....	.....	65	29	49	10	10	20	5	..	.....	..	..	..	58	62	67	73	10	17	27	5	0	NOTE.–Improvement based on 41 cases

NOTE.—19.5 per cent. had plastic flap operations. 27 per cent. had interneural gaps. 10 per cent. were indeterminate. 80.5 per cent. had end-to-end anastomosis. 73 per cent. had no gap or were not reported. 17 per cent. were failures. 73 per cent. were improved. 62 per cent. average degree of improvement.

mined that the nerve is completely severed, in which case operation should be undertaken as soon as the latent infection has cleared up. If at the end of six months there is no sign of regeneration, one of two courses may be followed: Anastomosing the distal end of the seventh nerve to the hypoglossal, or anastomosing it to the spinal accessory, preferably the latter.

SUMMARY

1. The regeneration of the peripheral nerves may be accomplished by nerve anastomoses.

2. The degree of regeneration depends on (*a*) duration of time between injury and repair, the shorter the period the greater the regeneration. The possibility of regeneration is very slight after three or four years, (*b*) actual loss of nerve tissue, and (*c*) retraction of severed ends.

3. In the technic of nerve repair (*a*) no covering is necessary if the freshened ends can be sutured in close apposition; (*b*) if an intervening gap remains it should be tubulized, preferably by fascia; (*c*) if the gap is longer than 5 cm. tendon transplantation and arthrodesis should be considered instead of nerve anastomosis; (*d*) autogenous transplants may be considered for short gaps, but they are of no greater value than tubulization; (*e*) in all technic, the wound should be free from hemorrhage and infection and the nerve ends should not be traumatized; and (*f*) during the post-operative convalescence, the paralyzed muscles should be massaged and passive motion should be administered.

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RHINOPHYMA*

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of Philadelphia, Pa.
Surgeon to the Pennsylvania Hospital, Professor Surgery, Jefferson Medical College

This distressing disfigurement occurs in the third or hypertrophic stage of acne rosacea. Fortunately, in spite of the frequency of acne rosacea, this condition is not an inevitable or even common termination of the disease.

It is inseparately associated, especially in the layman's mind, with inordinate indulgence in alcoholic beverages, but it has occurred in the case of many very temperate persons and has been often seen in total abstainers: consequently, we may hardly expect it to disappear with the enforcement of the recent amendment to our Federal Constitution. Excessive use of tea, coffee, tobacco and good food, as well as extreme cold and heat, are considered by the dermatologists as causative factors. There is probably no comfortable indiscretion which has not been named in this connection, so there is nothing more to add in the way of causes, but as far as the three cases here reported are concerned, I think they may be acquitted of any charge of over-indulgence in the flesh pots. A fact probably worthy of note is that rhinophyma is very rare in women and yet they are notoriously indiscreet in their treatment of the alimentary tract, both as to what they put in it and the regularity with which they evacuate it.

Looked at pathologically this condition can be expressed in one word —hypertrophy—involving particularly the connective tissue, the sebaceous glands and the blood-vessels of the skin. The most striking of the hypertrophic features is the great size of the sebaceous glands, their big blocked ducts and their apparent increase in number. The big tortuous capillaries and veins are conspicuous superficially but they are not found to the same extent in the deeper portions of the skin. The thickness of the skin even in the absence of lobulation is surprising. The usual limitation of the hypertrophy to the lower half of the nose is difficult to explain but renders its surgical treatment much easier. Where pendulous lobules of hypertrophied skin hang from the alæ, the skin at their bases is never so thick as in other parts of the involved area. This renders simple excision followed by suture possible in many cases. There seems to be no limit to the growth of the lobulated masses. In Keen's case, the only one I believe reported before this Academy (January 4, 1904, Annals of Surgery, vol. xxxix, page 665), the patient was obliged to lift his enlarged nose up out of the way in order to take soup from a spoon or

* Read before the Philadelphia Academy of Surgery, March 13, 1919.

liquid from a glass. If the commonly assigned cause of this condition is the true one, it is unfortunate that the patients are not so handicapped in the early stages of the disease.

Electrolysis and galvano-cautery puncture probably constitute the only methods of treatment of this disfiguring condition which may be said to be generally practised, and yet I am inclined to believe excision under a general anæsthetic gives better, quicker, more certain and more lasting results.

I assisted Doctor Keen in 1903, when he operated upon the case already referred to, in which the result was most gratifying, and since have operated on three cases. Unfortunately I have failed to locate two of these patients recently, but the results engendered great gratitude in the patients, and I believe if any marked recurrence had taken place they would have returned. The photographs before and after in two of the cases show what was accomplished. No photograph was made in the second case, but the condition in this case was quite as marked as in the others, interfering, as the patient assured me, with his "business" (that of a pedlar), and the result equally good.

The surgical procedure is quite simple and consists of excision of the lobules and the paring or shaving of the hypertrophied skin until the nose has assumed the size and shape which might be considered normal. The work might be considered more suited to a sculptor than to a surgeon.

Although bleeding is very profuse from innumerable vessels, it is very rare that any of these require a ligature: even the use of forceps is rarely required excepting in the case of the vessel at the base of the ala. One should be careful not to pare away the entire thickness of the skin because if this is done it delays healing and necessitates the formation of cicatricial tissue. In Case I it will be noticed that there are two such areas on the left ala.

The way in which the sebaceous material exudes from the divided sebaceous ducts and skin is quite like that of butter or cheese squeezed through a piece of cheese-cloth. One can readily believe that there is not only a hypertrophy of the sebaceous glands but an increase in their number. When the nose by the process of shaving has been brought to what may be considered normal, the bleeding can be arrested to some extent by hot applications and pressure, but oozing will continue for a number of hours. I have allowed several layers of gauze to remain in contact with the denuded area for a number of days and have simply changed the outer layers of gauze. If the entire thickness of the skin has not been removed, it is remarkable how quickly healing takes place in these cases.

The surgical procedure and the results are so satisfactory that I am convinced that many more of these cases should be operated upon.

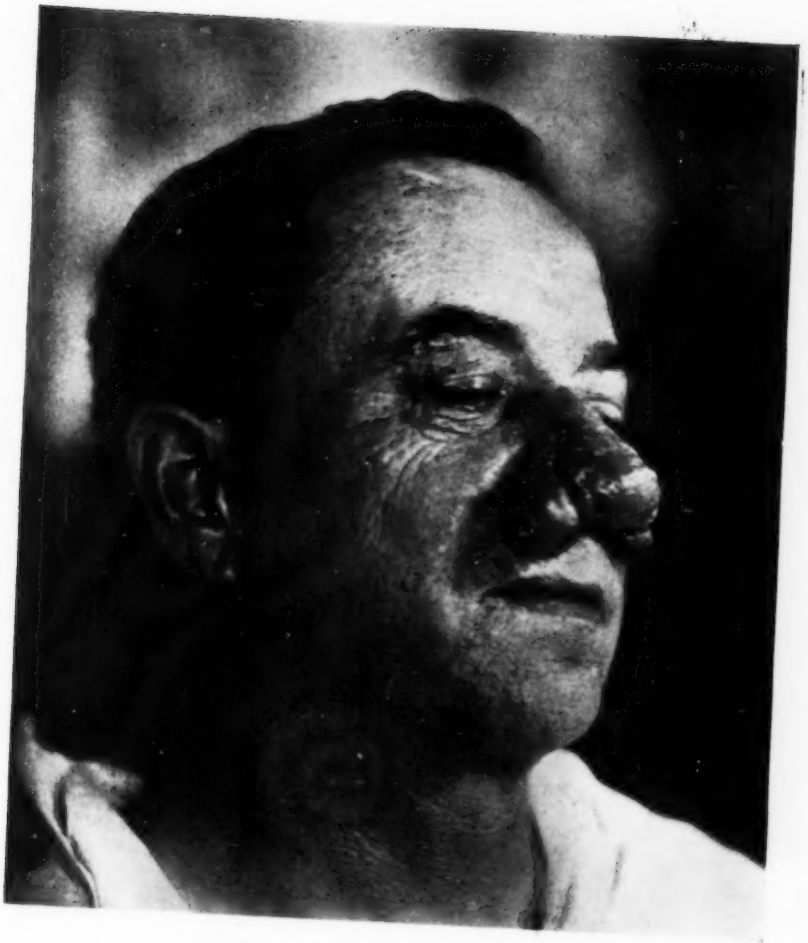

FIG. 1.—Case I before operation.

FIG. 2.—Case I, fourteen days after operation.

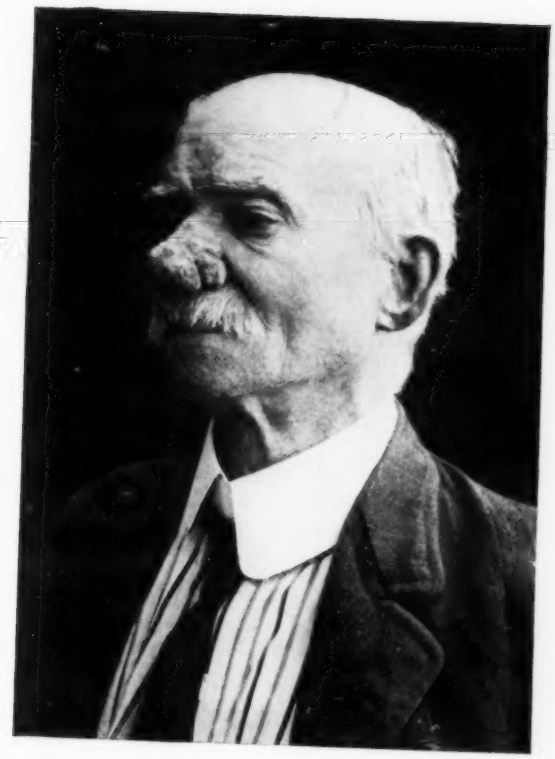

FIG. 3.—Case III, before operation.

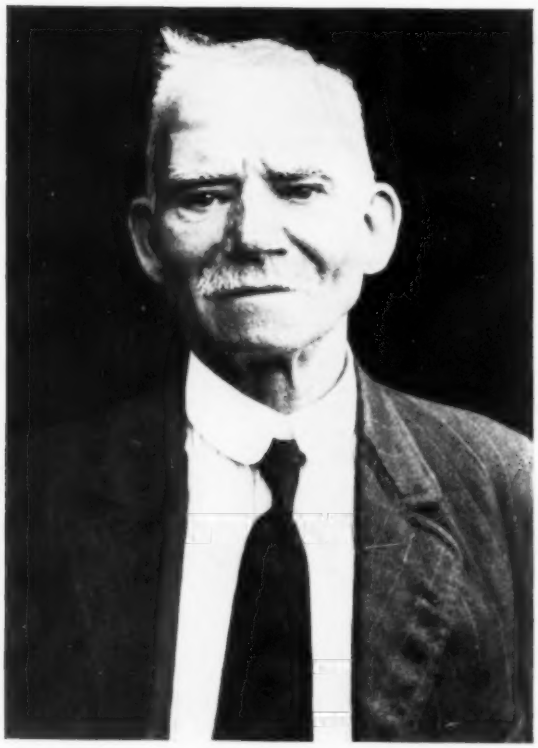

FIG. 4.—Case III. twenty-eight days after operation.

CASE I.—T. H., aged fifty-seven years, operated upon at the Jefferson Hospital, February 2, 1907. Fig. 1 shows the appearance of the nose before operation and Fig. 2 the condition fourteen days later. In this case there were four small points, two on each ala, where the entire thickness of the skin was removed and here epithelialization was delayed about a week.

CASE II.—A. M., aged fifty-five years, operated upon at the Pennsylvania Hospital, October 22, 1913. In addition to the involvement of the nose in this case there were numerous small sessile masses of hypertrophied skin on the cheeks. Some years previous the patient had a large pedunculated mass removed from the right side of the nose. Because of an old chronic inflammatory condition of the lungs, this patient was operated upon under chloride of ethyl anæsthesia. In this case I avoided penetration of the skin and the promptness with which healing took place was very surprising.

CASE III.—J. A., aged sixty-three years, operated upon at the Jefferson Hospital, June 20, 1916. In this case the involvement of the skin extended over nearly the entire nose. The second photograph was taken a month after the operation. This patient was seen within a few weeks of this printing, and he had had no recurrence of his trouble after three years.

TRANSTHORACIC LAPAROTOMY *

By Willy Meyer, M.D.
of New York
Attending Surgeon to the Lenox Hill and Post-Graduate Hospitals

Access to the organs within the abdominal cavity has been gained from every conceivable direction, according to the purpose of the operation and location of the field to be attacked.

Besides the great variety of incisions in front and over the sides of the abdomen—perpendicular, transverse, curved, angular, flap—we have learned to reach appendix and gall-baldder, cæcum and colon simultaneously with operations on the kidney; uterus and appendages through the vagina; rectum and sigmoid from the sacro-coccygeal region. The favored route for the opening of a subphrenic abscess has been through the complementary pleural space, with the help of rib resection and incision through the diaphragm.

In cases of injury to organs in the vault of the diaphragm—convexity of liver, upper pole of spleen, cardiac portion of the stomach—the injury occurring by way of the chest, it has been found best to have the incision follow the course of the injury; that is to say, after performing thoracotomy and attending to the injuries inflicted on the intrathoracic organs, the surgeon deliberately incises the diaphragm or enlarges the visible wound in the same and deals with the abdominal organs as the case may demand, (transthoracic—also transpleural or transdiaphragmatic—laparotomy).

Ferdinand Sauerbruch was the first to proceed systematically along these lines. Standing on the firm ground of the employment of a differential pressure apparatus, he carried thoracotomy to its logical conclusion in these cases. He reports three emergency operations of this kind:[1]

Case I.—Compression of thorax; no external lesion. Increasing serious symptoms demand operation. Intercostal incision (7th), under differential pressure, shows rupture of lower lobe of left lung. Incision through diaphragm. Large effusion of blood; pedicle of spleen torn; splenic vein bleeding. Extirpation of spleen. Suture of diaphragm and lung; closure of chest. Recovery.

Case II.—Young man with shot wound of thorax, right side near middle line, at level of costal arch, demanding prompt intervention. Intercostal incision (6th). Wound found in middle and lower lobe of lung, also of pericardiophrenic artery and in diaphragm. Suture of lung wound; ligature of bleeding vessel. Division of diaphragm. Liver torn at convexity. Tampon left in latter and conducted outward through abdominal stab. Suture of diaphragm and thoracic wound. Recovery.

Case III.—Shot wound in left seventh intercostal space. Abdominal muscle spasm gave indication for thoracotomy, in the course of which the diaphragm had to be split and the injured organs within the thoracic and abdominal cavity were attended to. Recovery.

Sauerbruch lays stress upon the necessity of dividing the diaphragm in a direction transversely, or at least obliquely, to the direction of its

* Read before the American Surgical Association, June 16, 1919.

[1] Trans. of German Congress of Surgeons, 1912, i, p. 142.

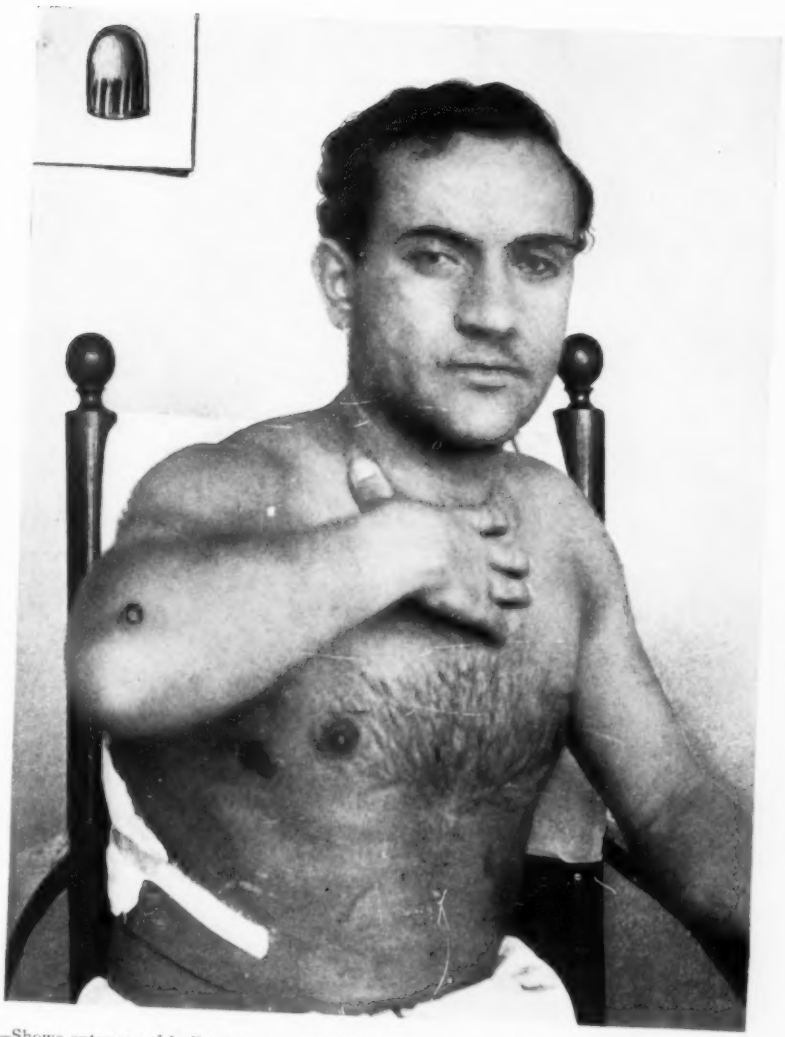

FIG. 1.—Shows entrance of bullet in arm and chest (sixth intercostal space). Insert at upper left-head corner: The bullet which was extracted from the liver; actual size.

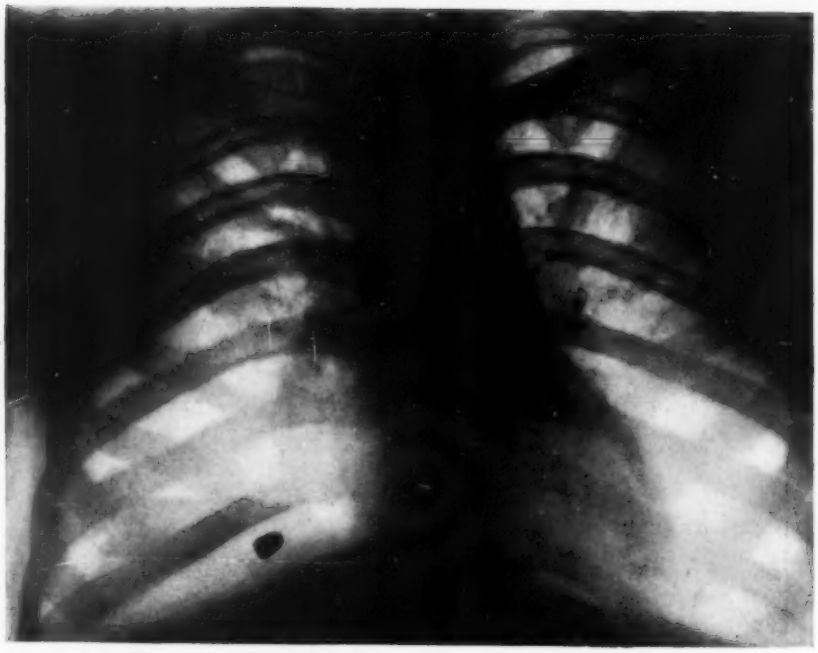

FIG. 2.—Radiograph, showing bullet in lower portion of right chest.

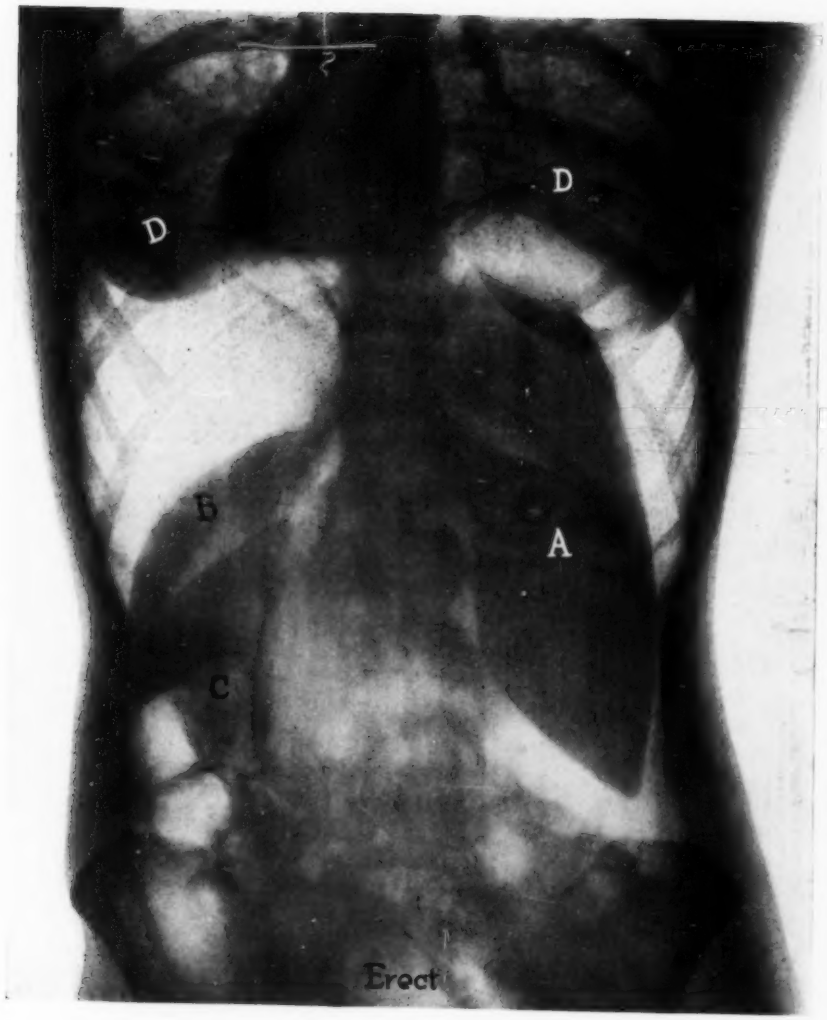

FIG. 3.—Shows the immediate effect of insufflation of oxygen into the peritoneal cavity. Note the pronounced dropping away of liver and spleen from the diaphragm. (Reproduced here by courtesy of Dr. W. H. Stewart, of New York. See ANNALS OF SURGERY, July, 1919, page 96).

FIG. 4.—Illustrates air-tight thoracic drainage, as carried out in every case of thoracic operation under the author's care at the Lenox Hill Hospital, New York. For immediate and unobstructed inspection the drainage bottle is placed under the lower end of the bed. Patient rests on his back with right shoulder and hip supported on small pillows.

FIG. 5.—When tired of one position during the time of drainage, patient can also turn on his right side, with the drainage of the right chest not interfered with (right latero-abdominal posture).

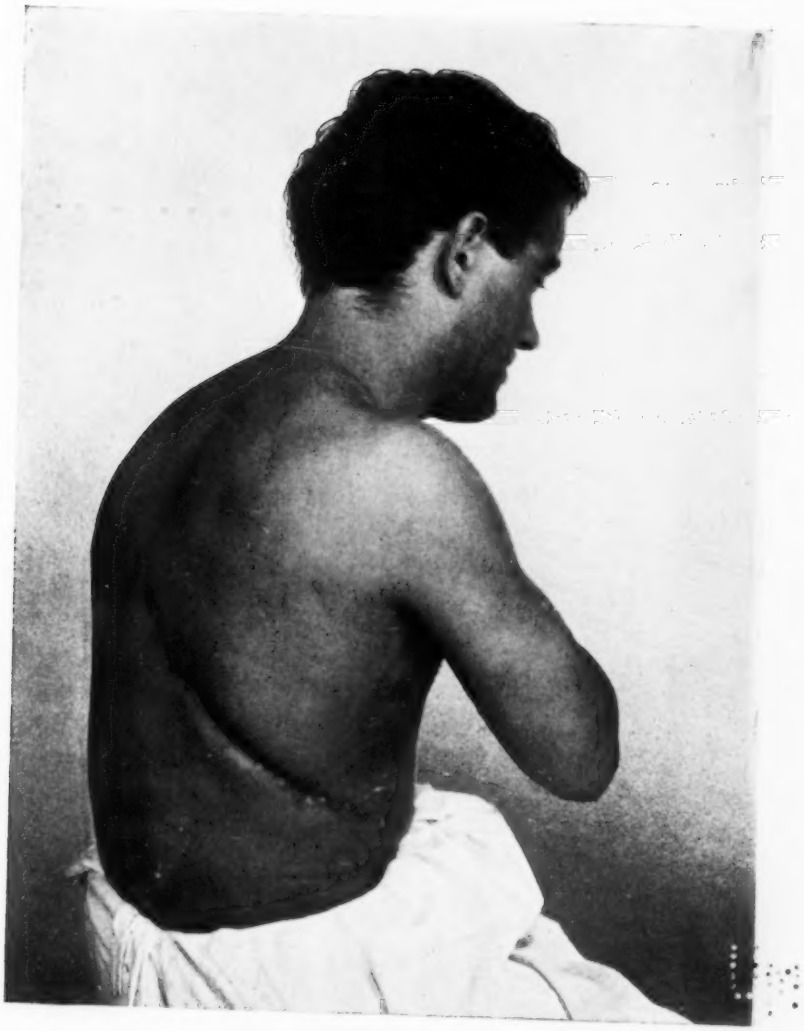

FIG. 6.—Intercostal incision healed.

muscular fibres—*not parallel* with the same—in order to avoid injury to the phrenic nerve, which would paralyze the diaphragm on that side.

A further case belonging to this group was reported by Kenneth Bulkley before the Surgical Section of the N. Y. Academy of Medicine, in November, 1916.[2]

Stab Wound of the Chest and Diaphragm; Thoracotomy; Laparotomy; Packing of Punctured Spleen, Recovery.—Boy, fourteen years, stabbed in left lower chest with a knife, one-half hour before admission. Through the wound, one-half inch in length, protruded a bit of omentum. Resection of ninth rib. It is seen that the knife had penetrated the pleural cavity without injury to the lung, and had inflicted a wound in the diaphragm through which the omentum prolapsed. The omentum was amputated, the stump reduced and the rent in the diaphragm closed. Pleural drainage. Twelve hours later signs of peritoneal irritation and intra-abdominal hemorrhage. On incising the abdomen it was found that on the diaphragmatic surface of the spleen was a punctured wound, nearly an inch long, still actively bleeding; packing with gauze. The drainage tube in the chest was removed after thirty-six hours, the abdominal packing after forty-eight hours, and both wounds healed practically per primam. Patient was presented in good condition one week after the injury.

In January of this year, I had occasion to do a transthoracic laparotomy on a patient who had been wounded about six weeks before his admission to the hospital with the chest wound firmly healed. As the case presents a few features of interest, I shall report it in full:

J. G., an Italian, thirty-one years of age, was accidentally shot on November 29, 1918, with a 32-calibre pistol. The bullet entered just above the external condyle of the right humerus and passed through the tissues of the arm, without injury to the bone, blood-vessels, or important nerves, although the point of exit corresponded to the inner (bicipital) sulcus. It then entered the thorax in the sixth intercostal space, in the anterior axillary line, fracturing the seventh rib (Fig. 1). There was no exit of the bullet. The man was admitted to one of our city hospitals and recovered without operation and without serious symptoms. He claims to have coughed some blood during the first days, but definite information regarding this point could not be obtained.

Not long after his discharge from the hospital, he consulted Doctor Carlo Savini, of New York, who had a stereoscopic X-ray picture made. This showed the bullet seemingly in the lowest portion of the right side of the chest, most likely within the lung (Fig. 2). Doctor Savini very kindly referred the patient to me for an opinion regarding indication for removal of the bullet by operation. The man seemed to be in excellent condition and had no special complaints, excepting now and then drawing sensations in the region of the injury.

According to formerly entertained views, expectant treatment was here in order. If no untoward symptoms developed, the patient might carry the bullet for life. Some of our best surgeons with

[2] Report of meeting of November 3, 1916, New York Med. Record, January 27, 1917.

wide experience still adhere to this view at the present time. In rendering my opinion I tried to consider the patient's future. It seemed to me, if the bullet was in the lung, the case might well be placed on a level with an interval appendix operation, demanding a prophylactic interference in order to avoid more serious consequences. I considered that an exploratory thoracotomy done at this time—with the bullet within the lung tissue—might afford a chance of finding and removing it. Such an operation certainly involved less risk to the patient than a possible future suppuration within the lung; and should the bullet be found within or below the diaphragm, conditions encountered during the operation would have to be the guide as to further procedure. Besides, I remembered that excellent remark of Sir Berkeley Moynihan's: A bullet in the body is two bullets, *i.e.*, one in the respective organ, the other in the patient's mind. I advised operation and, with Doctor Savini's consent, had the patient admitted to the Lenox Hill Hospital. Before proceeding, another stereoscopic radiograph was taken, and the patient repeatedly examined fluoroscopically by Dr. W. H. Stewart, the radiographist of the Lenox Hill Hospital; but the bullet could not be definitely located. The report reads:

"Fluoroscopic, combined with serial röntgenographic examination of the right chest reveals a bullet located between the tenth and eleventh ribs. Under the fluoroscope we noted that the bullet would rise and fall with the diaphragmatic movement. I am suspicious, therefore, that it is lodged within this muscle, or in close relation to same. It lies well posteriorly."

No matter whether in this case the bullet was situated within the lowest portion of the inferior lobe of the right lung, or within the diaphragm, or below the same in the liver, it was evident that it could be reached with safety only by way of the chest, not by way of the abdomen.

Operation (January 8, 1919).—Intratracheal insufflation (Doctor Muehleck). Incision in right eighth intercostal. Contrary to expectations, an absolutely free pleural cavity was entered; only the inner aspect of the lower lobe of the lung was firmly adherent to the diaphragm. In view of the experience had by our colleagues in the war, I had first intended not to prepare for the emergency use of differential pressure, but to make a simple intercostal incision, expecting to find far-reaching adhesions. Now I felt happy that I had prepared for and was ready to meet the emergency. There is no doubt that without a differential pressure method already in action, the patient would have suffered an acute operative pneumothorax with its possible consequences, until positive or negative differential pressure could have been applied to relieve the situation. The thorax, having been incised with the apparatus in action, no annoying symptoms occurred.

The lung was allowed to collapse somewhat. Careful palpation of the lower lobe failed to find the bullet. A small, round scar in the diaphragm seemed to point to its penetration by the bullet. Turning

the palm of the hand and going carefully over the lower diaphragmatic vault, the bullet was palpated posteriorly to the central convexity of the diaphragm, quite a distance from the sternal aspect, and to the left of the median line.

The question now was: Should I continue the operation and remove the bullet?

On the day preceding the operation I had met one of my colleagues at the hospital who has seen considerable active war service. We discussed the case. He condemned operation. "One ounce—more or less—of lead in the body would make little difference," he said, "whereas the operation, as planned, might prove serious, if not disastrous to the man." My conscience then began to plague me. I did not want to do an operation without definite indication, but I also thought of the two points mentioned above, particularly Moynihan's words, and therefore concluded to adhere to my decision to do an exploratory thoracotomy and, if necessary, pneumotomy. Now, suddenly faced with the fact that the bullet was not in the thorax at all, but was probably embedded in the liver, I found it difficult to decide whether to go ahead, or let the patient take the chance of having a liver or subphrenic abscess develop later on—the worst that possibly could happen.

Next to me, watching the operation, stood my old friend, Doctor De Vecchi, of New York, for whose good judgment I always have had the highest regard. I asked him for his opinion and he said: "Doctor, you have done a big exploratory operation; you are down upon the bullet; go ahead." And then he repeated Moynihan's words which we had discussed before beginning the operation. Although I hesitated for a moment as to whether I would be doing the best for the patient, I saw the correctness of Doctor De Vecchi's opinion and started to divide the diaphragmatic vault six to seven inches below the level of the chest wall. This proved no easy matter, partially on account of the depth, partially on account of the continuous motion of the field of operation. To steady it with stick-sponges seemed impossible. With a straight, long bistoury the abdominal cavity was entered by an incision about 2½ inches long. Quite some arterial hemorrhage from the diaphragm was encountered, but a clamp placed on either side of the phrenic wound nicely controlled it. The subdiaphragmatic space was then entered. It was perfectly free. There were no adhesions of any kind. The bullet was palpated within the liver. Again a somewhat difficult and rather delicate step in the operation followed, *viz.*, to pass the cautery through the opening in the diaphragm so far down, avoid cauterization of the diaphragmatic wound, and then correctly incise the liver which naturally shared the diaphragmatic unrest. I did not dare enter the liver with a knife, for I had no technical chance of properly dealing with a hemorrhage. So I drew a line with the cautery through the liver substance, where I felt the bullet, and repeated this a second and third time, when suddenly pus was struck. A small quantity partially oozed out and

partially was pressed out and caught on wipes; a culture was taken. The bullet was found and removed from the liver. It was a short 32-calibre missile (Fig. 1).

The unexpected presence of pus changed the situation and the plan of the operation. The liver wound bled slightly and was difficult of access; blood had run down into the subdiaphragmatic space, and now, in addition, pus had been encountered. Tamponade was required. Should I treat the abdominal and the thoracic cavities separately and conduct a gauze strip, placed into the liver wound, and a second one, introduced into the subphrenic space below the liver incision, out through a special stab in the abdominal wall, and then close the wound in the diaphragm and drain the supposedly infected pleural cavity? It certainly seemed the most surgical procedure. However, I considered the whole field of operation infected, the subdiaphragmatic space, as well as the wound in the liver, the wound in the diaphragm, and the pleural cavity, and, therefore, a straight drainage by means of the tampons through the diaphragm and thoracic cavity appeared more advisable, whether rightly or wrongly, I would not venture to decide; but I feared a further contamination of hitherto unhandled intra-abdominal regions. Besides, it is customary to drain the posterior aspect of the liver and subphrenic space through the lower portion of the thorax, though this is usually done after stitching the borders of the diaphragm to pleura and posterior periosteal sheath of the resected rib, thus shutting off the pleural cavity above. The wound in the diaphragm was therefore closed up to the tampons by interrupted sutures, and Kenyon's drain placed in the posterior angle of the thoracic wound. The latter was closed as usual, in layers, tightly, with pericostal chromic gut retention sutures and a continuous suture for the various muscles and the skin. The gauze drains were cut short in front of the chest, and the perforated cork, surrounding the Kenyon drain, pressed upon the same as a buffer after a small piece of split gauze had been pushed underneath the safety pins, securing their ends. The skin surrounding the drainage region was then heavily covered with sterilized zinc ointment and a large, partially split piece of rubber dam put on top of it all, thoroughly surrounding the Kenyon drainage tube and covering the round cork-plate, through which it passes. The rubber dam was intended to act as a valve, should the gauze drains permit air to pass. The dressing was completed with dry gauze, held in place by 2-inch strips of zinc adhesive plaster, and a temporary Desault bandage, to fixate the right arm for the first twenty-four hours. The patient reached his bed in good condition. As a prophylactic measure the heart was stimulated with hypodermic injections of sodium benzoate of caffeine and camphorated oil and the phrenic irritation quieted with morphine and atropine. The head-end of the bed was raised on blocks.

Sero-sanguinolent drainage in the first twenty-four hours, 250 c.c.; in the second, 35 c.c.; in the third, 30 c.c. (Figs. 4 and 5). Heart

action soon became normal, but temperature fluctuated. First change of dressing on the sixth day after operation. There being no certainty that adhesions had formed to keep the lung distended throughout, the precaution was taken to change the dressing with the help of the positive cabinet. The two gauze drains in the liver substance and subphrenic space were removed without difficulty, giving exit to a small amount of sero-sanguinolent fluid; Kenyon's drain was left *in situ* undisturbed and the dressing secured and covered as at first. Some retention of sero-sanguinolent fluid was found in the skin wound and drained. The temperature in the evening of the same day was 103.2°; pulse strong and quiet; general condition good. Kenyon's drain was removed and exchanged for a small sized rubber tube two days later. After repeated dressings the tube could soon be removed. The patient made an uneventful recovery (Fig. 6).

The foregoing rather extensive description of the operative experience has seemed permissible, in view of the pus, so unexpectedly encountered in the liver, evidently representing a beginning hepatic abscess. It at once changed the entire aspect of the operation as well as of the after-treatment. Although the serological examination of the culture taken proved the pus to be sterile, the only advisable procedure at the time of the operation, in view of the unknown character of the pus, was: *drainage*.

The previous transthoracic laparotomies for liver or spleen injury in the vault of the diaphragm had been made soon after the accident, and before suppuration could have set in.

The diaphragm has also frequently been split in the course of thoracotomies, which were done in cases of œsophageal and cardiac carcinoma in order to reach and deal with the diseased portion of the stomach. But there again, the rent could be sutured immediately afterward, closing the abdominal cavity, and drainage was not indicated.

No doubt, during the war, surgeons have often been called upon to enter the abdomen through a chest wound, the course of the injury demanding or inviting such an advance. It is to be hoped that they will publish their experiences. Conditions found in such cases are somewhat different from those in the case related here, inasmuch as in the war injuries the chest had been open for some time, and the question of avoiding the deleterious effects of the operative and post-operative acute pneumothorax did not have to enter the surgeon's deliberations.

After the operation, related above, the question came up whether the seat of the bullet in lung, diaphragm, or liver could have been properly diagnosed before operation.

According to a communication made by Doctor Stewart before the American Association for Thoracic Surgery at its Second Annual Meeting at Atlantic City, June the 9th this year, a differential diagnosis as to the location of this bullet might have been possible röntgenographically,

after establishment of an artificial pneumothorax and insufflation of oxygen into the abdominal cavity. Doctor Stewart has taken up the latter procedure on a larger scale, as the first in America, in conjunction with Dr. Arthur Stein, of New York City, Associate Gynecologist to the Lenox Hill and Harlem Hospitals, the method having been proposed and tried by Lorey, of Hamburg, and Weber, of Kiew, seven (respectively six) years ago, and having been discussed in literature repeatedly in the course of the last years.[3] Doctor Stewart's radiographs, showing the effect of oxygen insufflation into the peritoneal cavity with reference to bringing out details, are beautiful and convincing (Fig. 3). His article was published in the July, 1919, issue of the ANNALS OF SURGERY.

The conclusions that could be drawn from this case and the other transthoracic laparotomies on record are the following:

1. Recent wounds which have entered the abdomen through the chest and have likely seriously injured one or more of the principal organs situated within the vault of the diaphragm are best promptly explored with the help of a transthoracic laparotomy.

2. Injuries to the convexity of the liver or upper pole of the spleen, without previous penetration of the chest, if not satisfactorily accessible from below, can be thoroughly attended to by the surgeon if he follows the transthoracic route.

3. The experience gained in general in the last war would seem to hold good also for bullet wounds of the convexity of the liver inflicted in times of peace, *viz.*, to remove the missile and therewith eventually avoid more serious consequences to the patient later on.

4. Whether the operation should be done immediately after the accident or later depends upon the seriousness of the comcomitant symptoms of the patient. If a prompt, transdiaphragmatic attack is not made imperative by increasing symptoms of pressure-pneumothorax or severe internal hemorrhage, a secondary operation may be best for the patient.

5. These operations are best done with the help of some differential pressure apparatus.

6. In case of the necessity arising to leave tampons in the abdomen, it appears best, from a surgical standpoint, to deliver them through a special abdominal stab. The diaphragmatic wound can then be sutured, and thus the physiologic separation of thoracic and abdominal cavities be reëstablished.

7. Temporary air-tight drainage of the chest appears here, too, to be the safest procedure for after-treatment.

8. The establishment of an artificial pneumothorax and oxygen insufflation into the abdominal cavity bid fair to make the röntgenologist definitely localize the seat of the bullet if it be found near the diaphragm.

[3] See, E. Weber: Fortschritte auf dem Gebiete der Roentgen-strahlen. Vol. xx, 5, 1913, and O. Goetze, Muench. Med. Wochenschr., November 12, 1918.

DIAPHRAGMATIC HERNIA

By Joseph L. DeCourcy, M.D.
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From recent literature on the subject it appears that diaphragmatic herniæ, of the non-traumatic type are more frequent than ordinary supposed. Two of the early cases reported were those of Cranwell (*Rev. de Chir.*, January, 1908) and N. B. Carson (*Interstate Med. Journal*, April, 1912) operated successfully through the transthoracic route. Recently Angelo L. Soresi (Annals of Surgery, March, 1919) reported a case operated successfully through the peritoneal cavity. Other cases have been reported and various modes of treatment described.

The following case presented itself to our clinic in the latter part of April, 1919. The symptoms recorded resembled very closely those presented by Case I of Dr. Angelo L. Soresi and therefore I will outline his case first in order to show the resemblance.

Case I (Soresi).—"Miss M. E., aged nineteen, girl poorly developed and rather anæmic. Her history is one of long suffering, dysmenorrhœa, constipation, indigestion, and severe pain in the abdomen, the nature of which the girl cannot explain better than by saying that she suffers every time she has her menses, that she had once a very severe pain in the right side of her lower abdomen, that she had for a long time a dull pain over there, that she suffers from indigestion and constipation, that at times she cannot breathe, that she feels like crying all the time; in fact, she is a rather neurotic subject, discouraged and very melancholic. When seen by the writer she complained especially of pain in the lower abdomen and pain all over her chest and stomach."

As I have already stated the symptomatology of my own case closely resembled the above.

Case II.—Miss I. V., aged twenty-five, girl poorly developed and rather anæmic, began to menstruate when seventeen years of age. She has suffered since beginning menstruation with dysmenorrhœa, constipation and indigestion. Before this time she could not be positive whether or not the constipation and indigestion existed. In the past few years the symptoms have become progressively worse and she now has severe epigastric pains, whereas previously only a sense of fullness and indigestion existed. The pain at present seems to come on immediately after eating and I have placed great importance upon this point in the symptomatology. Vomiting occurs without premonition and seems to gush from the patient. She complains of smothering and shortness of breath at times. Physical examination revealed the heart pushed one and one-half inches to the right of the sternal margin and hyper-resonance over the area previously occupied by the heart.

The X-ray report of Dr. Wm. M. Doughty was recorded as follows:

Fluoroscopically and with stereoscopic plates of the chest we discovered an area which varied in size at different times from that of a small orange to an area twice that size, which began in the middle line and extended from two to four inches from the diaphragmatic attachment on the left side, upward, then obliquely extending from this upper portion outward and downward and to the right, joining the diaphragm two inches from the median line to the extreme lower part of the right chest. This was easily demonstrated as containing air in the upper portion and fluid in the lower portion by movement and by palpation which gave us a fluid wave over the upper edge of the opaque shadow. At all times the heart shadow was shown slightly more to the right than normally.

The opaque meal given by mouth was seen to enter normally through the œsophagus, through the cardiac end of the stomach, the greater curvature of the stomach being distinctly seen and that part of the stomach shown being higher up in the abdomen and higher up to the left. The normal amount of barium used for stomach examination readily filled that part of the stomach in the abdominal cavity and was easily expressed into this previously described area, above the right diaphragm, through a narrow opening to the right of the œsophagus. At no time was I able to see the pylorus or any of the opaque meal leaving the stomach and entering the small bowel while the stomach remained in this position.

Allowing the patient to stand for half an hour without any manipulation or sensation upon any part of the body, the examination then made disclosed the stomach to be entirely within the abdominal cavity, being quite long, the entire fundus being within the pelvis, and by palpation under the fluoroscope it was easy to entirely fill the pylorus and rather duodenal cap which at all times was placed higher in the abdomen and expressed this meal from the duodenal cap into the normal second portion of the duodenum.

All of this following the elapse of half an hour was shown to be in the abdominal cavity.

The twenty-four-hour examination showed the entire colon to be in normal position in the abdomen, very freely movable and with normal progress to the opaque meal.

There was one small opaque shadow of barium, freely movable, which was shown to be between two and three inches above the central part of the transverse colon and very slightly to the right of the median line which I could not demonstrate to be either in the stomach or in the colon. I would consider this as probably being a slight diverticulum filled with the opaque meal and its attachment I could not discover.

The operative findings were as follows: A long, high right rectus incision was made about one-half inch to the right of the median line. The abdominal walls were retracted and lifted so as to expose the entire abdominal cavity. With this exposure neither the stomach nor the transverse colon could be seen. A small portion of the omentum protruded from beneath the left lobe of the liver. By making traction upon the omentum the transverse colon and stomach were returned with some difficulty into the abdominal cavity. During this manipulation the sound of air could be heard passing into the tissues about the stomach.

After the stomach was returned to the abdomen the tear in the diaphragm could not be seen, but the tissues about the gastro-hepatic omentum would rise with each inspiration, giving the impression of air

beneath. When these tissues were opened, it could be seen that we were dealing with a distinct sac entering the pleural cavity and closely adherent to surrounding structures. To perform a classical operation upon the diaphragm in this case was entirely out of the question because of the dangers which would be incurred when working about such a complicated area, so that we had to be satisfied with passing a silk purse-string suture about the sac at the diaphragmatic opening. The opening in this case was to the right of the œsophagus about one and one-half inches in diameter and it appeared that the lesser curvature of the stomach entered the opening first and dragged the transverse color after.

Immediately after closure of the sac the suction ceased.

Symptomatology.—In studying the foregoing cases and other cases which have been reported in the literature, I will try to lay stress upon a few symptoms which, in my opinion, point to non-traumatic cases of diaphragmatic hernia. (Because of better evidence these cases must be considered as congenital, whether or not they are remains for later study.)

(*a*) Pain Immediately After Eating.—Pain after eating has always been a more or less certain symptom of stomach ulcer, and the symptoms of diaphragmatic hernia frequently resemble ulcer (my own case was treated for stomach ulcer for one year), but the farther the pain from the time of eating the more apt we are to be dealing with ulcer. Pain immediately after the ingestion of food, with distress and a sense of fullness, is suggestive of diaphragmatic hernia in which the stomach is herniated.

(*b*) Paroxysms of smothering and difficulty in breathing attributable to no other cause.

(*c*) Vomiting coming on with a gush and without premonition.

The objective symptoms, such as the heart being pushed to the right and tympanites over the area where the heart originally lay, together with the foregoing subjective symptoms, should at least suggest diaphragmatic hernia. The X-ray, although a great aid in diagnosing these cases, should not be considered as conclusive in the face of negative findings, as can readily be seen in the picture in which the abdominal contents have returned to their normal habitat.

The treatment consists of closure of the tear in the diaphragm whenever possible either by the transthoracic or transperitoneal route. The route to be chosen is still a question and rests with the individual operator.

I chose the abdominal route because from the X-ray findings I was reasonably sure that there were no tight adhesions—because one picture taken after the patient stood for one-half hour showed the stomach returned to the abdomen—and it is well to try to determine the extent of adhesions by this method. I do not believe in condemning the transthoracic route because of the dangers of artificial pneumothorax—this condition is just as apt to occur through the rent in the diaphragm when the abdomen is opened and in my opinion danger of this condition is overestimated.

In my own case I could not close the tear in the diaphragm by any given procedure: this was due to the adherence of the sac to the surrounding structures. Were it not for the sac, I think that with the exposure which we had the closure could have been accomplished.

In conclusion, I wish to say that from the majority of cases on record the most common site for non-traumatic diaphragmatical hernia is at the œsophageal opening. That a reasonably certain diagnosis can be made, certain enough to warrant an exploratory incision. That the X-ray may be used to confirm the diagnosis, but is useless in the face of negative findings.

THE ASSOCIATION OF MALIGNANT MYOMATA WITH MECKEL'S DIVERTICULUM

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By far the greater number of tumors composed of smooth muscle tissue—the so-called leiomyomata—originate, of course, in the uterus, and it is estimated that between 1 and 2 per cent. eventually undergo malignant transformation.[1] This may be brought about in one of two ways, at least, first, by the development of genuine sarcomata from the connective tissue of the interstitium, and, second, by direct transformation of the muscle fibres, or mesodermal elements, into cells whose histology and vegetative vagaries correspond to the form and behavior of the cells of an autonomous malignant growth. Strictly speaking, this latter type of tumor should not be classified among the sarcomata, but as a malignant myoma. For practical purposes, however, most writers on the subject employ the term myosarcoma to designate a malignant tumor which develops either from the connective tissue framework or from the smooth muscle elements of a leiomyoma. In still other quarters it is maintained that the proliferation of muscle cells occurs primarily in the walls of the blood-vessels with which the tumor is provided.

In addition to the familiar uterine leiomyomata, smaller but histologically identical tumors occasionally are to be observed at autopsy or operation, either singly or in numbers, lying in the musculature of the stomach, intestine, gall-bladder and elsewhere. In our autopsy experience at Bellevue Hospital they occur in less than 1 per cent. of cases and the individual tumors rarely exceed a centimetre in diameter, projecting, as a rule, beneath the serous surface, sometimes into the lumen. They are apt to be regarded as interesting but otherwise negligible. As a matter of fact, there is evidence to show that these apparently insignificant growths undergo malignant transformation with a degree of frequency which entitles them to notice as factors of clinical importance. Although there are but a few cases of so-called myosarcoma of the intestine, stomach and gall-bladder to be found in the literature—five to be exact, a sixth being added in this paper—it is to be recalled that the accidental discovery of apparently innocent leiomyomata in these situations is correspondingly rare. From this it would appear that the capacity of the latter for malignant transformation is proportionately greater than that of their prototype, the uterine leiomyomata. It is permissible, perhaps, to dismiss this phase of the problem with the statement that all extra-uterine malignant myomata originate, not from pre-existing leiomyomata, but

from the mature smooth muscle structures normally resident in the parts concerned. Such an opinion is gratuitous, however, rather than justified by any process of reasoning from established facts.

A case recorded by Ghon and Hintz[3] exemplifies the probable pathogenesis of the intestinal and related malignant myomata. A man, aged 50, who during life presented symptoms of intestinal obstruction, showed at autopsy 50 or more large and small growths scattered through the wall of the small intestine. Microscopically they were composed of a ground work of cells whose form and arrangement were strikingly like the ordinary leiomyoma, but in addition, there were numbers of large, polymorphous, richly nucleated cells such as commonly are accepted as histological criteria for the determination of malignancy in uterine leiomyomata. In addition, metastatic growths of a closely related histological type were found in the subcutaneous tissues of the abdomen, in the thyroid, lungs, periosteum of the breast bone, in the intercostal muscles, liver, pancreas, adrenals and kidneys, and in the marrow of the femur and vertebræ, together with neoplasmic thrombosis of the azygos veins.

The same authors record a case of histologically typical malignant myomatous transformation of a leiomyoma of the jejunum occuring in a man 45 years of age. The tumor was 5½ cm. in diameter and lay between serosa and mucosa. There were no metastases. A third case observed by them was that of a shoemaker, 81 years of ago, in whom at autopsy a tumor 15 by 16 cm. was found arising from the greater curvature of the stomach and reaching to the level of the ileocæcal valve. The histological picture was that of a leiomyoma with malignant changes in the muscle cells, and there were metastases from the muscle tumor into the head of the pancreas, the liver, left lung, the left ventricle of the heart and the wall of the urinary bladder. In addition, the subject presented multiple lipomata of the stomach, small intestine and mesentery angiomata of the œsophagus, small intestine and mesentery, and a carcinoma of the fundus of the stomach with metastases which, in places, showed cancer* cells lying directly in the metastatic deposits from the muscle tumor.

A fourth example of extra-uterine malignant myoma is recorded by Landsteiner,[4] and consisted of a greatly enlarged gall bladder in the walls of which was a massive tumor reaching thence into the substance of the liver. Microscopic examination showed a typical malignant tumor of the sort familiarly described as a myosarcoma. In the liver were numerous metastatic growths of the same histological description. In the mucosa of the gall bladder, on the other hand, was a tumor the microscopic appearances of which were those of an epithelioma with pearl formation.

In the Pathological Laboratories at Bellevue Hospital I have recently had occasion to study a remarkable malignant myoma of identical histology with those just synopsised, but springing from the base of a

* In connection with the extraordinary question of the metastasis of metastases, as recorded by Ghon and Hintz, two examples encountered in Bellevue Hospital[3] of the metastasis of independent tumors are of interest. In one patient, a woman, thirty years of age, a myofibroma of the uterus was removed at operation. The patient stated that some months previously a pigmented mole had been removed from the anterior abdominal wall. Section of the uterine tumor revealed two small pigmented nodules in its interior, and these, upon microscopic examination, were found to represent metastasic melanomata. The patient died later of generalized pigmented growths. A second case was that of a woman from whom was removed a massive cystadenoma of the ovary, microscopic examination of the walls of which showed metastatic deposits of melanoma. The patient stated that she had previously been operated upon and a growth removed from one eye.

FIG. 1.—Anterior view of growth. *A*, Walls of diverticulum containing, microscopically, remnants of smooth muscle fibres. Mucosa destroyed. *B*, Cuff of small intestine with well-preserved mucosa and musculature. *C*, Leiomyoma, covered by atrophic but otherwise well preserved mucosa continuous with that of the loop of intestine marked *B*. *D*, Base of the growth showing, microscopically, multiple areas of malignant transformation.

FIG. 2.—Posterior view, showing the obulated character of the growth and its extension into the walls of the diverticulum above.

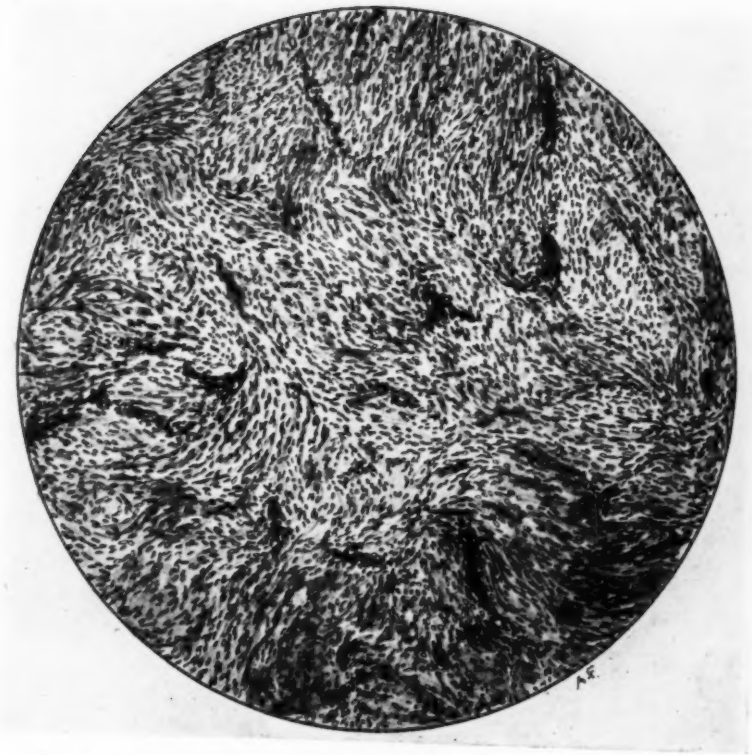

FIG. 3.—Microscopic structure of the intestinal leiomyoma marked *C* in Fig. 1.

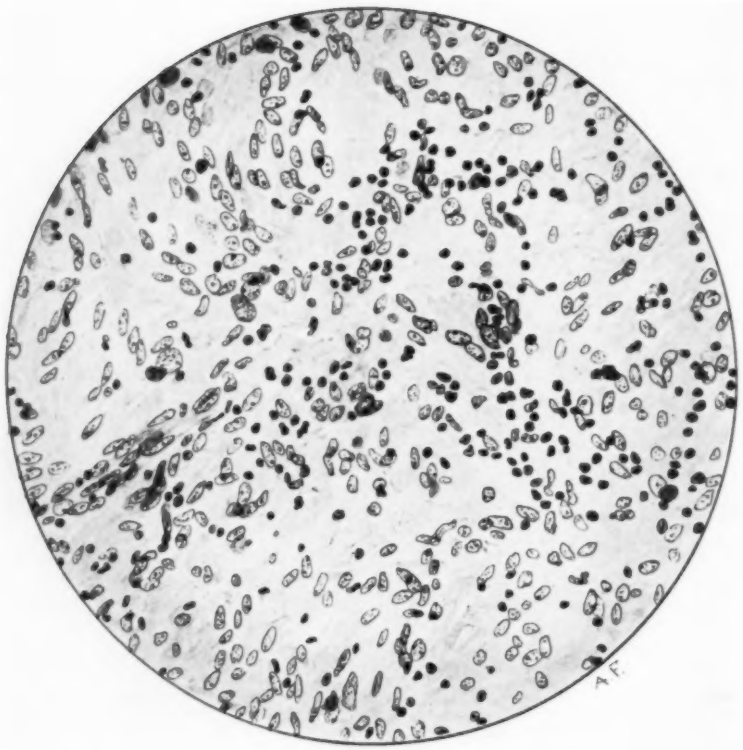

FIG 4.—Microscopic structure of a malignant portion of the growth removed from that part marked *D* in Fig. 1. Note the loose arrangement of the muscle cells, the variations in size and in the form and chromatic richness of the nuclei, together with the presence of a multinucleated giant cell.

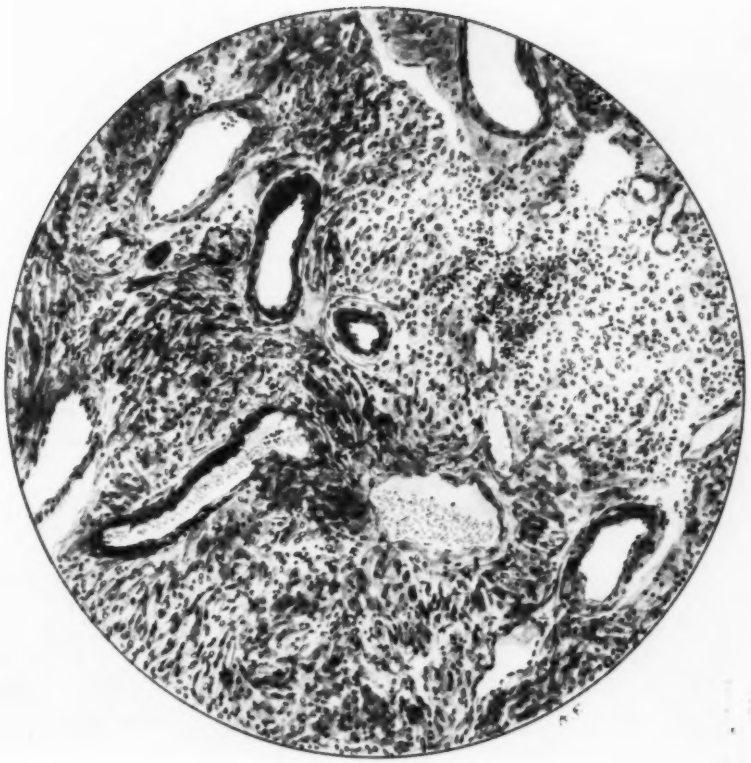

FIG. 5.—Microscopic appearance of another part of the same growth (Fig. 1, *D*) showing numerous blood-vessels with thick and well-nucleated walls and an occasional multinucleated syncitial mass lying among the tumor cells, suggesting derivation from the blood-vessel walls.

Meckel's diverticulum of the ileum. The growth occurred in a man, twenty-two years of age. It was discovered by accident in the course of an operation for hernia by Doctor Sweeny. No symptoms traceable to its presence could be elicited.

The specimen, as received in the laboratory, consisted of a mass measuring about 10 cm. in length and 5 in breadth, removed from the convexity of the small intestine, 30 cm. above the ileocæcal valve (Fig. 1). For purposes of description, the specimen is divisible into two parts—an upper, rounded and elastic to the touch, and a lower solid portion. On opening the upper part it was found to consist of a pouch-like formation, lined on the inner side by a roughened, dirty brownish, apparently structureless membrane. The lower portion consisted of a firm, whitish or cream-colored, irregularly lobulated growth, which completely encircled the base of the pouch-like dilatation by which it was surmounted, lobular prolongations from the growth extending upward into the walls of the diverticulum and gradually disappearing therein. On opening the mass it was found that the walls of the diverticulum merged imperceptibly into a cuff-like tube, the lining of which was thrown into small transverse folds of apparently well-preserved intestinal mucous membrane. Projecting into the lumen of this portion of the intestine was a large, pale, firm, whitish tumor, covering the surface of which was a delicate membrane continuous with and presenting the same naked-eye appearances as the cuff of intestine by which the projection was surrounded. Externally the loop of intestine was reënforced by an irregularly lobulated growth, which, on section, presented a smooth, pale surface, where, at intervals, were reddish specks corresponding to injected blood sinuses (Fig. 1, *D*).

Microscopic examination of the wall of the diverticulum showed the presence of a ground substance of connective-tissue, which in places was dense and hyaline in other places moderately fibrillar and more or less richly infiltrated by small round cells. In still other places the connective tissue enclosed quantities of bright yellow pigment, lying in which was an occasional multinucleated foreign body giant-cell. Here and there remnants of smooth muscle bundles were visible. There were no detectable remains of mucosa (Fig. 1, *A*).

Microscopic examination of the tumor projecting beneath the loop of intestine (marked *C* in the illustration) showed the histology of a typical leiomyoma; that is to say, the growth was made up of a number of small, spindle-shaped cells arranged in intercommunicating bundles or whorls, the whole supported by a delicate reticulum of connective tissue, the former staining yellowish by the Van Giesen method, the latter reddish (Fig. 3). The surface of this part of the growth was covered by an atrophic but otherwise well-preserved layer of intestinal mucosa.

Microscopic preparations were made from the base of the growth—that part marked *D* in Fig. 1. The tissue was cut in frozen sections or in celloidin, and stained with hæmatoxylin and eosin and by the method of Van Giesen. Microscopic examination revealed a groundwork the histology of which was not to be distinguished from that of a moderately cellular leiomyoma, such as commonly is encountered in the uterus—intercommunicating bundles of spindle-shaped muscle cells, with cigar-shaped nuclei supported by a delicate reticulum of connective tissue. At fairly frequent intervals, however, were areas in which the compact fibro-muscular structures merged into groups of polymorphous cells, which were arranged loosely and without any semblance of order. Their nuclei varied in shape and chromatic richness, and among them multinucleated giant-cells were fairly common (Fig. 4). In still other places the growth was composed of cellular areas in which blood-vessels were numerous, the walls of the individual vessels being thickened and unusually well nucleated. In such areas multinucleated syncitial masses were occasionally to be seen lying among the tumor

cells (Fig. 5). Some of the multinucleated masses were of such character as to indicate that they might have been separated from the vascular wall, others were of the same type as the multinucleated cells seen in other parts of the growth.

I have been able to find but one case of like origin in the literature of medicine,[5] that is to say, a malignant myoma or so-called myosarcoma of Meckel's diverticulum. The patient was a fifty-five-year-old individual who became more and more cachectic without a clinically discoverable cause, and finally died. At autopsy a massive tumor was found arising from a point opposite the mesenteric attachment of a Meckel's diverticulum of the jejunum. The lumen of the diverticulum communicated with that of the intestine, through the medium of a tubular structure which was lined on the inside by intact mucosa and whose muscular coats were continuous with those of the jejunum. The growth in the diverticulum was made up of numerous whitish, firm nodules with areas of softening and hemorrhage. Microscopic examination of the tumor showed what was described as a fibromyosarcoma. The abdomen was filled by serous fluid. The liver was riddled with metastatic deposits and the lymph-nodes in the region of the primary focus were completely transformed into tumor tissue.

With the exception of a casual statement by Kaufmann [6] to the effect that "the Basle collection contains a spindle cell sarcoma of Meckel's diverticulum the size of a hen's egg that was found in a seventy-two-year-old woman" I have been able to find but one remaining example of a neoplasm originating in an intestinal diverticulum, namely, a case recently recorded by Black.[7] In fact, true tumors of genuine Meckel's diverticula are apparently among the rarest of rarities. So-called enterocystomas, on the contrary, are fairly common. Black's tumor weighed 4260 gm. and was removed from the tip of a diverticulum in the sigmoid region. The growth was examined by MacCallum, who pronounced it papillomatous. While it is not to be denied that this is an unusual situation for Meckel's diverticulum, the malformation in question has nevertheless been described there.

CONCLUSIONS

1. Subserous, occasionally submucous leiomyomata are encountered in the walls of the stomach, intestine or gall-bladder in less than 1 per cent. of autopsies. As a rule, they are solitary, rarely multiple. Seldom do they exceed a centimetre in diameter.

2. Judging from the small number of cases to be found in the literature of malignant myomata of the stomach, intestine and gall-bladder, and comparing this with the number of subserous or submucous leiomyomata met with in corresponding situations in the routine performance of autopsies, the assumption seems reasonably justified that these apparently insignificant growths undergo transformation into malignant

myomata with a degree of frequency which entitles them to attention as a potential source of danger. If accidentally encountered at operation, they should, I think, be removed.

3. The majority of malignant myomata of the stomach, intestine and gall-bladder thus far reported were found in organs which otherwise appeared to be intact. In other and rare instances, however, these malignant growths bear a definite anatomical relationship to the developmental malformation of the intestine familiarly known as Meckel's diverticulum.

4. The malignant myomata of the stomach, gall-bladder and intestine, including those associated with Meckel's diverticulum, are capable not only of extensive local expansion, but of widespread metastasis. Their degree of malignancy is apparently in excess of that of their prototype, the malignant myomata developing from smooth muscle tumors of the uterus.

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POST-INFLUENZAL ABSCESS OF THE SHEATH OF THE RECTUS MUSCLE *

By Homer Gage, M.D.
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The most important complication of surgical interest which was met with in the epidemic of influenza last fall, as it was the most common, was undoubtedly empyema. Opportunity for its study and observation was not wanting in any community, and reports have already been published from many quarters.

But the grouping of many thousands of cases under one roof and under the care of the same staff in the army hospitals afforded an unusual opportunity to observe some of the less frequent but no less interesting complications. Chief among these in our experience at the Base Hospital at Camp Devens was a group of localized abscesses situated for the most part in tissues about the joints and in the muscles of the trunk.

There were three about the ankle, three about the shoulder, two about the elbow and one in the popliteal space.

None of them communicated with the joint cavity primarily, and in only one case was there extension into the joint secondarily; that was in an abscess over the outer malleolus in a colored man who was suffering at the same time from a post-influenzal psychosis, and in this case instead of leading to disorganization of the joint the process ultimately healed with restoration of good function.

These abscesses appeared in the second or third week of the disease, in some even later, and were characterized by swelling and tenderness, but no redness; joint motion was very painful and the appearance as well as symptoms suggested joint involvement.

All of those in which bacteriological reports are recorded showed pneumococci in smear or culture or both, and all recovered promptly under simple incision and drainage.

The point to which I wish particularly to call attention in these cases is that they represent a pneumococcus infection confined to the periarticular tissues, not affecting the bones or joints, and not appearing in the viscera which are the common seat of metastatic processes.

Of even greater interest were 3 cases of abscess in the sheath of the rectus abdominis muscle, interesting not only on account of their peculiar location but especially because we felt that we could trace their development through its various stages.

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* Read before the American Surgical Association, June 18, 1919.

The first case occurred in a white male, twenty-one years old, who entered the hospital on September 16 with influenza, had a definite pneumonia, apparently confined to the lower lobe of the right lung. At the end of the second week in October, when satisfactorily convalescent from pneumonia he complained of pain and tenderness in the lower abdomen, and on the 19th presented a definite globular swelling just above the pubes, elastic, not movable.

It suggested a large tense bladder, and when that was ruled out was still believed to be intra-abdominal. The temperature was not above 100.5°. The patient presented no signs of general sepsis. Incision revealed a large abscess in the sheath of the recti muscles which healed promptly under simple drainage. The bacteriological examination showed pure culture of pneumococcus Type I.

The second case was in a colored male twenty-five years old. He was admitted on September 12 with diagnosis of influenza and had pneumonia of left upper and right lower lobe. During convalescence on the 29th of October he developed a swelling in midline between umbilicus and symphysis with slight pain, tenderness and fluctuation. Temperature was unaffected. At operation several ounces of pus were evacuated from the lower end of the recti the culture from which revealed pneumococci which was not typed.

The third case was a white male, twenty-four years old, who entered the hospital September 28 with influenza, developed a pneumonia of the left lower and right middle and lower lobe, and was followed by an empyema of the left side. Pneumococci Type I were found in sputum and in pleural exudate. On the 10th of November he had a submammary abscess of the right side from which staphylococci and streptococci were recovered on culture, which healed within a few days after being opened.

His general condition was good and there were no indications of general sepsis. On the 27th of November, two months after his initial infection, he developed an abscess in the sheath of the recti just above the symphysis containing a few ounces of thick pus yielding on culture pure pneumococcus Type I. Recovery was uneventful and prompt.

A quite similar case has been brought to my attention by Dr. W. E. Ladd of the Boston Children's Hospital, which occurred in his service last winter, and through his kind permission the records have come into my possession.

It was that of a girl, ten years old, who was admitted December 8 with influenza, additional diagnosis, pneumonia right upper lobe with return to normal temperature on the 20th; then had suppurative otitis media, not severe, and on January 8 complained of pain and tenderness in lower abdomen. Incision revealed an abscess confined to the recti muscles, containing Gram-positive streptococci, which healed without complication.

The last case differs from the others only in that the infecting organism was a streptococcus instead of a pneumococcus. When we remember that the influenza bacillus is soon overwhelmed by the secondary invasion of

the pneumococcus or the streptococcus or both, the similarity with our own 3 cases seems perfectly evident.

In these 4 cases we find influenza followed by a secondary infection limited to the recti muscles without any of the general symptoms or of the multiple lesions that usually accompany pyæmic processes.

We are at once reminded of the degeneration of the abdominal muscles which has been often noted as a complication of typhoid fever, was first described by Zenker in 1864 and bears his name, and which has been fully described by our own Doctor Keen in his Toner Lecture on the Surgical Complications of Typhoid in 1876.

In a series of autopsies performed during the influenza epidemic at Camp Devens by Dr. S. Burt Wolbach, lesions precisely similar to those described in typhoid were noted in nine cases. They ranged from a swollen opaque yellowish-white appearance to the presence of large masses of blood clot occupying considerable areas of the recti muscles. The following extracts from the autopsy reports show the extent of the observed lesions:

Case I (September 30).—H. N. R. Recti for 8 cm. bove pubes are swollen and infiltrated with blood clot, and muscle is softer and more friable than normal.

Case II (October 1).—J. C. Recti from umbilicus to pubes swollen, and upper half of each is infiltrated with dark red blood clot. Fibres are widely separated and the cavities 0.5 to 1 cm. in diameter filled with clot. Pubic ends of muscles are pale, opaque and friable.

Case III (October 3).—E. G. Lower 8 cm. of recti opaque, pale, friable, yellow, and in the left small areas of hemorrhage 0.2 to 1.2 cm. long separating muscle fibres at junction of normal and yellow portions.

Case IV (October 4).—G. P. Lower 8 cm. both recti swollen opaque, yellowish white and friable.

Case V (October 4).—M. L. Muscles and chest normal except lower end left rectus is opaque, yellowish and slightly swollen for distance of 2 cm.

Case VI (October 7).—C. W. Upper part of recti streaked in pale grayish red lines and on the right side are punctate hemorrhages.

Case VII (October 8).—F. LeC. Lower ends of both recti from umbilicus to pubes greatly distended with dark red blood clot, and the retroperitoneal tissue on each side is infiltrated with blood for a distance of several cm. Muscles on section are soft, paler than normal, with large masses of blood clot separating fibres longitudinally and occupying spaces between transverse tears of the fibres.

Case VIII (October 11).—A. H. Lower one half rectus contains yellow opaque areas of striæ; on section portions of the muscle 1 to 2 cm. in length and 0.5 cm. in width are greenish yellow in color, opaque,—small areas of hemorrhage in muscle substance. Similar conditions at upper end right rectus.

Case IX (October 11).—W. J. E. Recti at extreme ends pale reddish gray or pink; no hemorrhage.

In the microscopic study of sections of muscles removed at autopsy Doctor Wolbach informs me that similar changes, though much less marked, are present in the other abdominal muscles and in other muscles of the trunk, such as the pectorals and the latissimus dorsi, though rupture of the muscle with accompanying hemorrhages, except microscopic, were not observed.

It seems probable that an abscess occurring beneath the lower angle of the scapula, following influenza and operated on before our attention had been drawn to these muscle changes, was of the same character, but it has not been included, because its exact nature was not recognized.

From these observations it seems quite clear that a Zenker degeneration of the recti muscles is a not infrequent accompaniment of influenza and influenza pneumonia, that the muscle fibres become so friable that rupture occurs with varying degrees of hemorrhage, and that more rarely still the blood clot may be infected by means of the predominant organism with resulting abscess.

These cases of secondary infection, those alluded to in the earlier part of this paper, as well as those limited to the recti muscle, suggest one problem of more than mere speculative interest.

Is there a definite selective action on the part of different organisms or different varieties of the same organism for different tissues as claimed by Rosenow?

Our observations at Camp Devens showed that we were dealing with an organism that attacked the pericardium frequently but not the endocardium; the structures around the joints, but not the bones or the joints themselves; the striped muscles, but not the unstriped; connective tissue, but not glandular; the abdominal wall, but not its contained viscera. Although, of course, satisfactory proof is still wanting, it hardly seems as if this selection could be purely accidental.

INDICATIONS FOR OPERATION IN URETERAL CALCULI

By Daniel N. Eisendrath, M.D.
of Chicago, Illinois

The discussion of the question whether or not to operate upon a case of ureteral calculus was a much easier task ten years ago than at the present time. This change in viewpoint is in great measure due to the rapid development of the non-operative methods of treatment, with which every surgeon should not only be familiar but give his patient the benefit of, before operation is considered.

The only exception to this rather dogmatic statement is in those cases to which I shall refer later, where the symptoms of renal infection predominate.

Even in this group of cases, an expectant plan of treatment is often rewarded by the subsidence of the acute symptoms, thus enabling one to deliver the calculus in the interval by one of the non-operative methods.

A correct diagnosis and a knowledge of the pathological changes which a ureteral calculus can cause are essential. At first glance it would seem as though it were superfluous to mention the necessity of such fundamentals. To one who has experienced the chagrin of operating upon a supposed calculus, and finding that the shadow was due to some extra-ureteral cause, such advice will not seem out of place. In a recent paper [1] I have compared the value of clinical evidence with that obtained through the employment of our modern diagnostic methods. The latter far outweigh the former for a number of reasons: (1) Experience has shown that there are many other causes for the symptoms formerly regarded as pathognomonic for ureteral calculus, namely, the so-called renal colic syndrome; (2) many ureteral calculi belong to the latent group which only give rise, as in one of the cases to be quoted later, to symptoms when infection of the kidney supervenes; (3) there are many extra-ureteral shadows which can deceive even the trained eye by their simulation, as to form, size and position, of a true intra-ureteral calculus. In the article referred to, I emphasized the necessity of utilizing every possible modern method of diagnosis. The ordinary X-ray single-plate method has been superseded in doubtful cases by the use of the stereoscopic exposures. The insertion of the opaque ureteral catheter was formerly considered to be all that was necessary to differentiate an intra- from an extra-ureteral shadow, but this led to erroneous conclusions in a sufficiently large number of cases as to force upon us the additional use of opaque solutions to fill the ureter and prove that the shadow was intra-ureteral by the fact that the ureterogram revealed either a nodular enlargement at the point of lodgement of the calculus or a uniform dilatation of the ureter proximal to the seat of obstruction.

A knowledge of the sequelæ of the presence of a calculus in the ureter is

[1] Diagnosis of Ureteral Calculi. Surgery, Gynecology and Obstetrics, 1918, 27, 461.

no less important to the proper comprehension of the indications for operation than the value of a correct diagnosis.

The following are the most common sequelæ:

1. In the ureter: (*a*) uniform dilatation above calculus; (*b*) stricture formation at point of impaction; (*c*) peri-ureteral abscess.

2. In the kidney: (*a*) pyelonephritis; (*b*) infected or non-infected hydronephrosis; (*c*) perinephritic abscess; (*d*) calculous anuria; (*e*) generalized sepsis (bacteræmia).

Some of these require special mention. The dilatation of the ureter occurs, as a rule, above the point of impaction of the calculus. Occasionally,

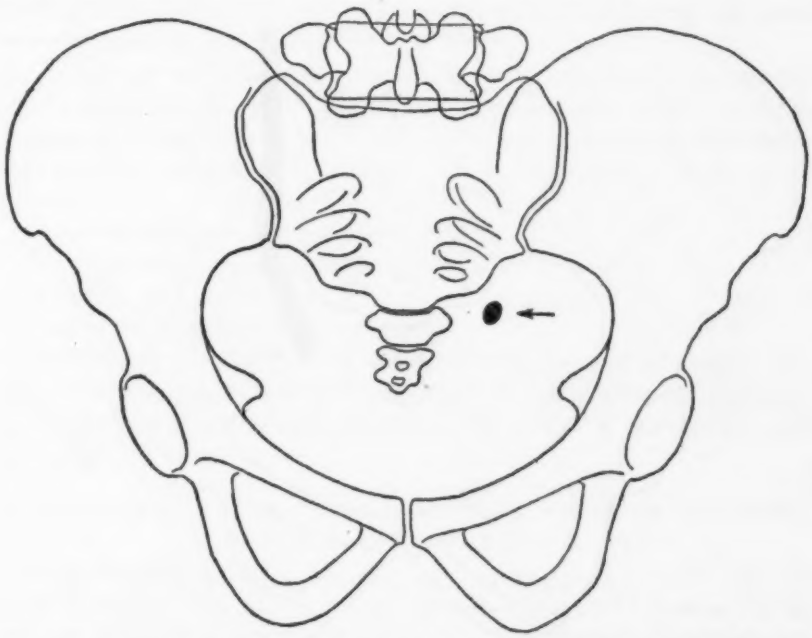


FIG. 1.—Arrow points to location of calculus in Case I of fruitless colics in which delivery of calculus by cystoscopic manipulation and injection of oil and albolene into the ureter was unsuccessful.

however, a spindle-shaped dilatation of the ureter is found, as in a case recently reported by Lower. Under these conditions we may have what is known as a wandering or floating calculus, which at times seems to be in the upper end of such a dilatation, yet when the ureter is explored at this point the calculus may have dropped down to the lower end of the dilatation and *vice versa*.

Stricture formation may not only occur as the direct result of the lodgement of a calculus at a given point, but has been known to follow a ureterotomy. At times a fistula may follow removal of a calculus from such a stricturated area as in one of the cases to be cited later. A peri-ureteral abscess is not a frequent complication, but there are a number of cases on record where a stone has ulcerated its way through the wall of the ureter

and has been found lying in the abscess cavity in close contact to the ureter or in the fistulous tract. The name "migrating calculus" has been given to this complication.

The kidney complications are of especial interest for the reason that catheterization of the ureter upon the side where a calculus is lodged is not always an easy task. Not infrequently we are obliged to remain ignorant of the exact condition of the corresponding kidney because we have been unable to secure urine directly from it or to make a pyelogram in order to determine the degree of dilatation of the renal pelvis or destruction of the parenchyma. Thus, as I will show by one of the cases to be quoted, our efforts at

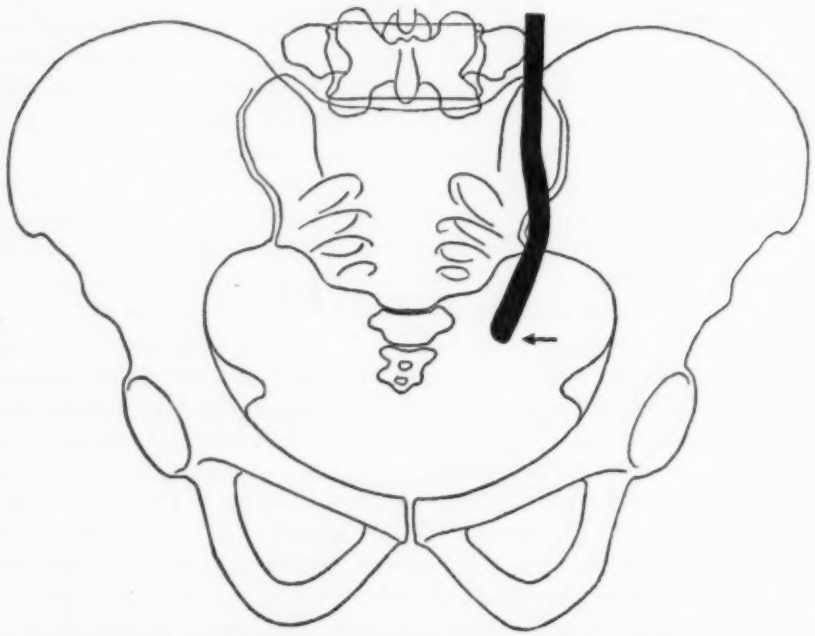


FIG. 2.—Ureterogram showing dilatation of ureter above point of impaction of calculus in same case shown in Fig. 1. Arrow points to location of calculus at lower end of ureterogram.

conservatism following removal of a calculus with complicating renal infection, are often defeated by our inability before operation to determine the exact nature of the pathological changes in the kidney.

I believe that I can best illustrate the most frequent indications for operation by citing some typical cases selected from my records:

GROUP I. FRUITLESS COLIC CASES IN WHICH NON-OPERATIVE METHODS HAVE FAILED TO DISLODGE THE CALCULUS

CASE I (No. 1584).—Male, aged thirty-three years. Typical ureteral colics at intervals for preceding two years. Examination showed an oval shadow (Fig. 1) just above bladder on left side of true pelvis. Use of X-ray catheter supplemented by ureterogram and stereoscopic

X-ray pictures showed shadow to be intra-ureteral. Ureter considerably enlarged (Fig. 2) above point of lodgement of calculus. Turbid urine containing many pus corpuscles escaped alongside catheter introduced beyond calculus in left ureter. Two attempts made to remove calculus using 2 per cent. papaverin with olive oil at one sitting and albolene at next. No change in position of shadow. Ureterotomy deemed indicated. Calculus about size of a navy bean, very firmly fixed in pelvic ureter just above bladder. Unable to push stone into bladder and could be only brought a short distance upwards with great difficulty. Uneventful recovery.

This case is an example of so-called fruitless colic. The position of the calculus had not changed in spite of a number of attacks during the preceding two and one-half years.

My standpoint at the present time is that one is not justified in operation upon such a case, especially if the stone lies in the pelvic portion of the ureter, until repeated attempts have been made to deliver it by one of the manipulative methods so familiar to urologists.[2] These methods may be enumerated as follows:

1. Injection of 2 per cent. papaverin alone.
2. Injection of 30 c.c. of albolene, glycerine or olive oil.
3. Injection of 1 and 2 combined.
4. Use of the Lespinasse laminaria tent.
5. If the stone is lodged in the intraparietal portion of the ureter, use of the Bransford Lewis or similar dilators and forceps, even if necessary to incise the mucosa of the ureteral orifice in the case of a calculus presenting at the vesical end of the ureter.

GROUP II. URETERAL CALCULI COMPLICATED BY A MORE OR LESS SEVERE DEGREE OF RENAL INFECTION

CASE II (No. 1162).—Female, aged twenty years. Left ureteral calculus with pyelonephritis. Ureterotomy followed by fistula due to stricture at point of lodgement of calculus. Nephro-ureterectomy for infected hydronephrosis.

Patient never had any symptoms until three days before admission, then had fever and pain in left upper abdominal quadrant radiating down ureter. No urinary signs. On admission left kidney was found enlarged and tender. Shadow like that of a bicuspid tooth in pelvic ureter (Fig. 3). Fever subsided in a few days after admission. Ureterotomy after eight days of normal temperature. Calculus found firmly impacted in pelvic ureter just below iliac vessels. Ureter very much thickened at point of impaction. Moderate degree of fever for eight days after this operation. Left hospital with sinus leading to ureter. Returned four weeks later with history of sudden recurrence of left renal pain radiating downwards with chills and fever. Large

[2] If a slight renal infection is present (see Group II) it is justifiable to make one or more efforts to dislodge and deliver the calculus. If much fever, however, is present, operation is indicated at once (see Case No. IV).

amount of turbid urine escaped from fistula at lower end of former ureteral incision. Cystoscopy revealed a marked cystitis. Ureteral catheter and bougies completely obstructed one and one-half inches above bladder. Ureter exposed, found size of adult finger, very hard with impermeable strictures below fistula. Ureteral plastic or reimplantation impossible. Kidney found much enlarged by palpating through ureteral incision. Kidney and ureter down to point of obstruction removed and found to be the seat of a very marked infected hydronephrosis (Fig. 4).

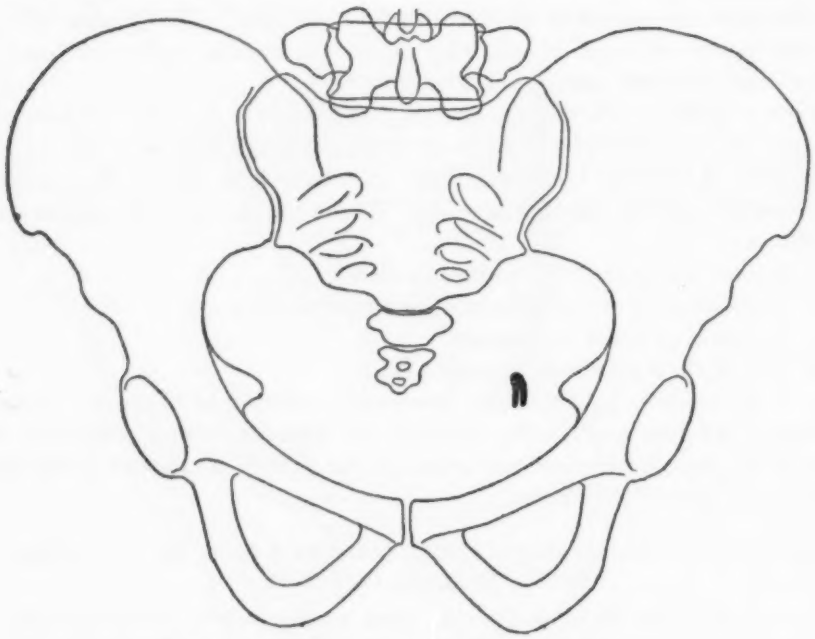


FIG. 3.—Location of tooth-shaped calculus in Case II.

This case illustrates an absolute indication (*a*) when the patient entered for the second time, on account of the evidences of infection of the kidney, and (*b*) an absolute indication for operation of the ureteral fistula.

CASE III (No. 269).—Male, aged thirty years. Symptoms of acute sepsis without localizing signs due to calculus impacted in upper end of ureter. Was well until five days prior to admission, when had chills, high fever and tenderness over kidney. X-ray examination showed shadow in lumbar portion of the left ureter (Fig. 5). Operation revealed a marked pyelonephritis with calculus impacted in lumbar ureter just below renal pelvis. Uneventful recovery, after nephrectomy and removal of calculus in lumbar ureter.

I have seen quite a number of similar cases in which the ureteral calculus had remained latent until the renal infection gave rise to the clinical picture so characteristic of that condition. This case illustrates the necessity

FIG. 4.—Kidney showing marked degrees of infected hydronephrosis due to impaction of calculus in pelvic portion of ureter (from Case II). Note dilated calyces and dark color due to intense infection of same.

of a routine X-ray examination of the urinary tract in all cases of sudden onset of febrile symptoms, with or without localizing signs, or even with those pointing to renal infection.

The following case illustrates how difficult it is to be conservative when renal infection complicates a ureteral calculus:

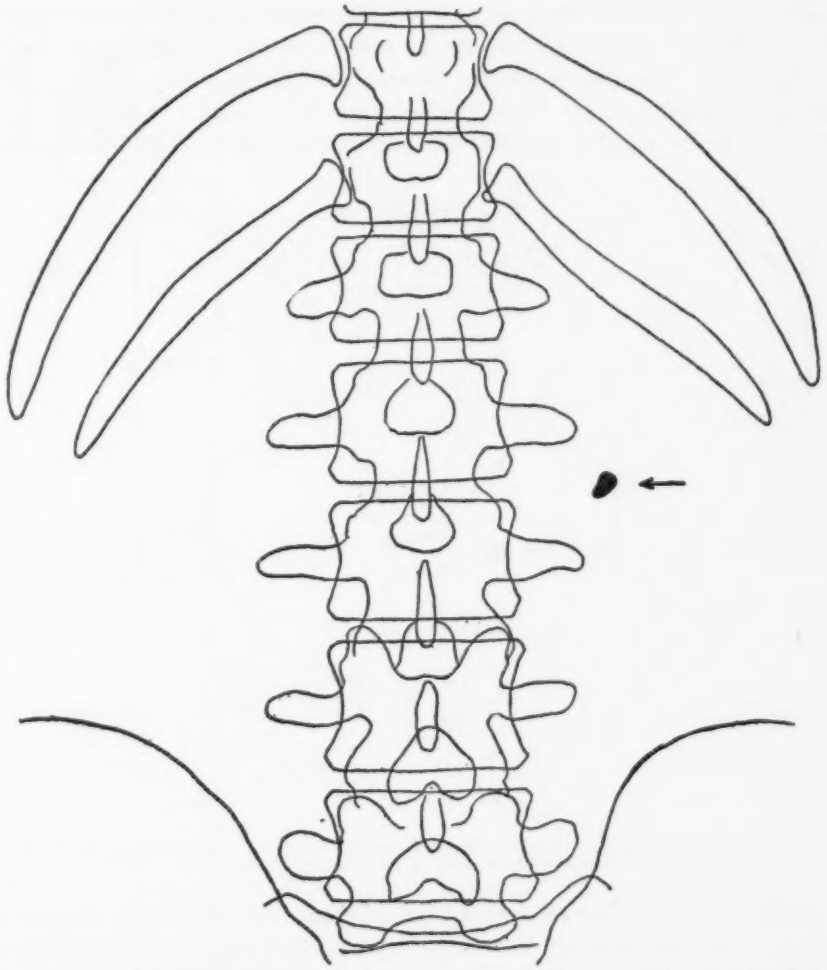


FIG. 5.—Location of calculus in Case III. Arrow points to calculus in lumbar portion of ureter. Symptoms of a severe renal infection completely obscured those due to a ureteral calculus. This case shows the necessity of taking X-ray pictures of the urinary tract in cases of renal infection.

CASE IV (No. 1491).—Male, aged forty-four years. Impacted calculus in left pelvic ureter. Severe renal infection not relieved by removal of calculus. Ureteral colics for two years before admission. Another attack about four weeks before being first seen, accompanied by fever and chills. No enlargement or tenderness of kidney. X-ray revealed triangular shadow in left pelvic ureter (Fig. 7). Able to pass catheter beyond calculus. Thick pus escaped. In the effort to save

the kidney the calculus was removed (Fig. 8), but the temperature persisted, requiring later nephrectomy. Large perinephritic abscess found at upper pole of kidney and extensive pyelonephritis.

It is very difficult to consider cases in Group II as a whole. The necessity of individualizing in each case is very apparent to those who have had much experience with renal infection. The tendency at the present time to be conservative and to try to save as many kidneys as possible by removing the cause of obstruction in the ureter, is not always rewarded by a cessation of symptoms. Case IV well illustrates this, because in addition to the infection in the renal pelvis and the parenchyma which might have yielded

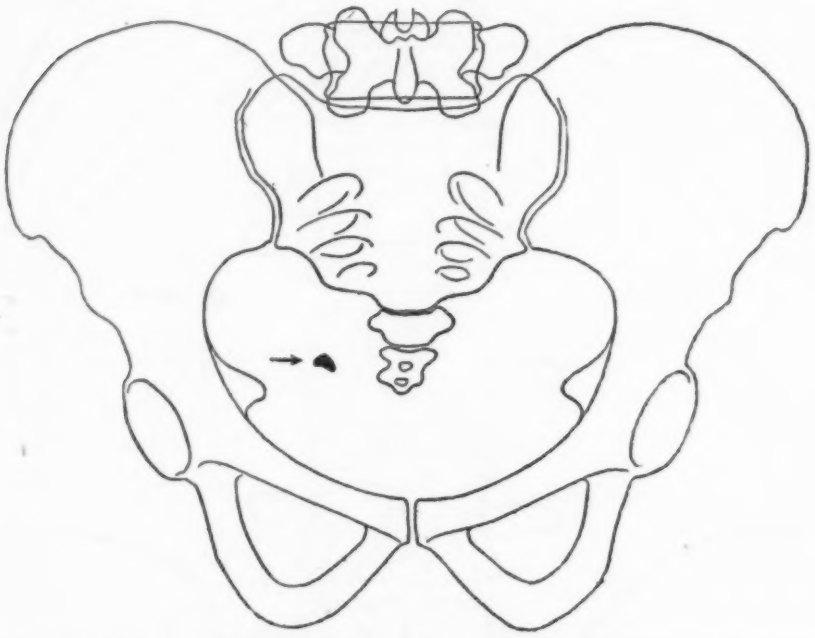


FIG. 7.—Location of shadow from Case IV of impacted calculus in pelvic portion of ureter. The severe renal infection was not relieved by removal of the calculus. Arrow points to calculus.

to better drainage after removal of the calculus, a perinephritic abscess was present. As the result of this latter complication the septic condition continued in spite of good ureteral drainage following the ureterotomy.

Much depends on the acuity of the symptoms and the degree of involvement of the kidney as determined by ureteral catheterization, functional tests and pyelography. If the clinical evidences of renal infection in the shape of fever, etc., are not very acute we are only justified in operating if either the expectant or non-operative methods of treatment are unsuccessful. I have had a number of cases with slight rise of temperature (100° to 101° F.) and a moderate degree of pyuria which have subsided completely after non-operative delivery of the calculus. In one of these cases which I have re-

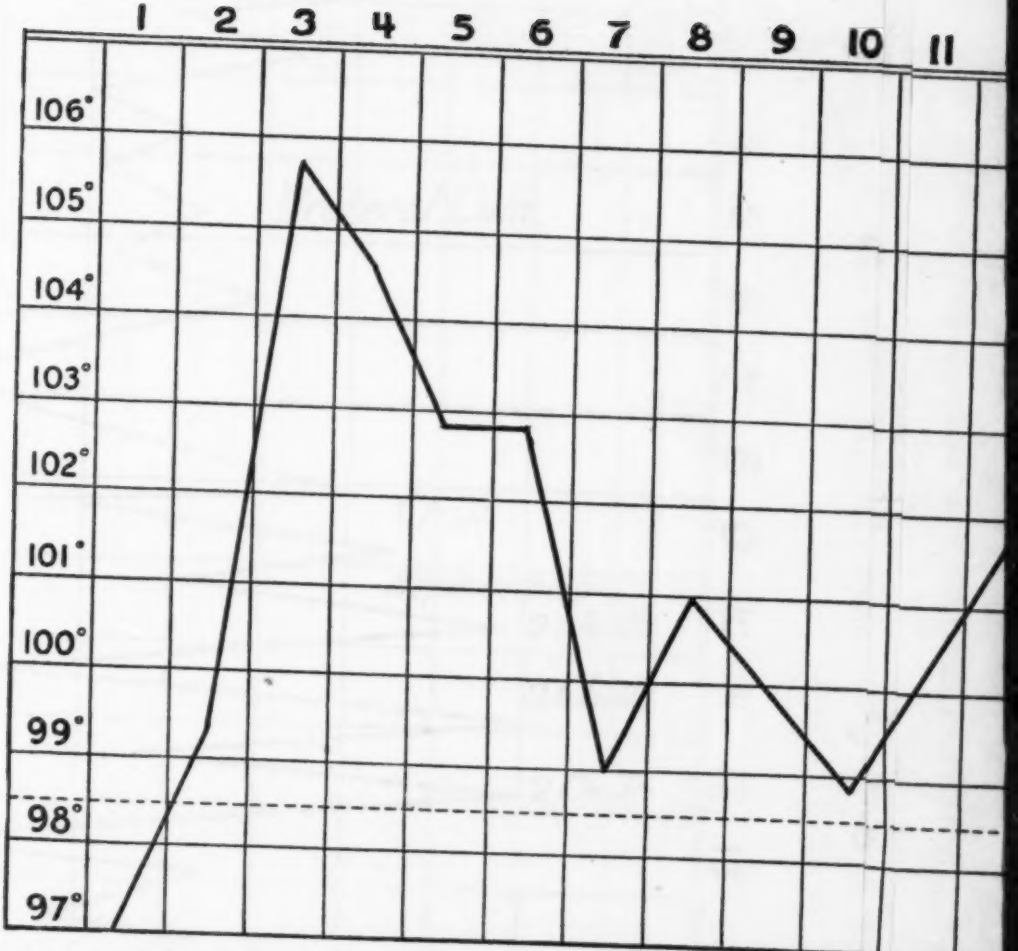
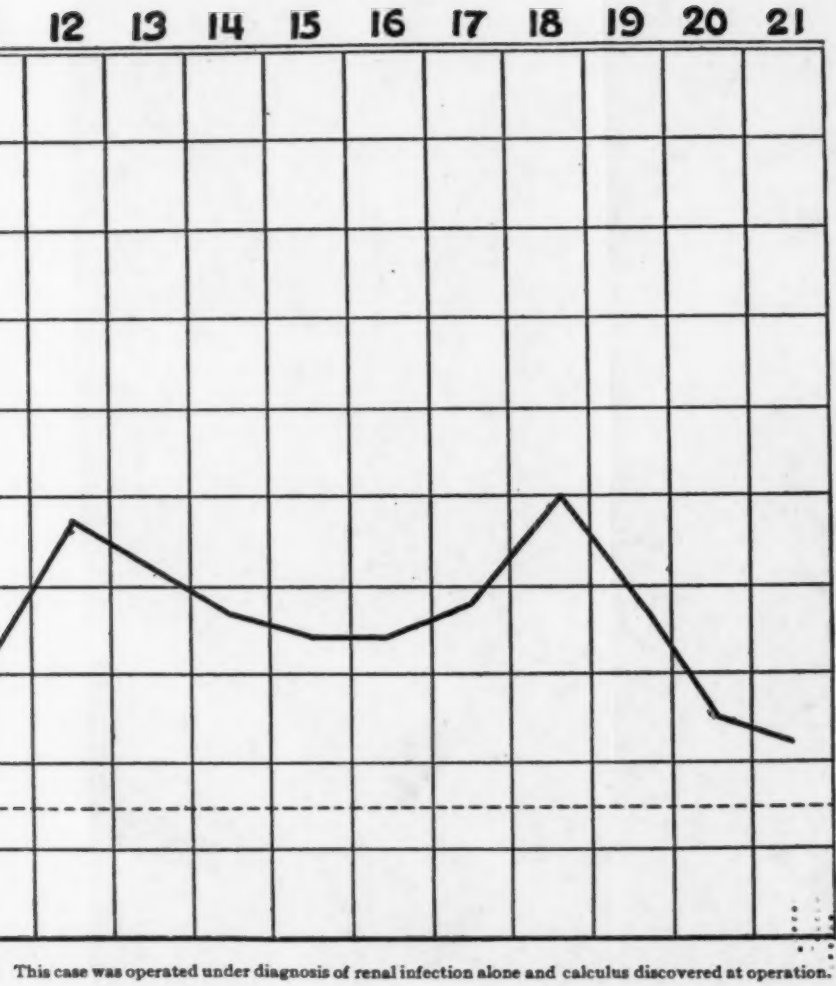


FIG. 6.—Temperature chart from case of severe pyelonephritis due to impaction of calculus in lumbar ureter. This case

m case of severe pyelonephritis due to impaction of calculus in lumbar ureter. This case was o



This case was operated under diagnosis of renal infection alone and calculus discovered at operation.

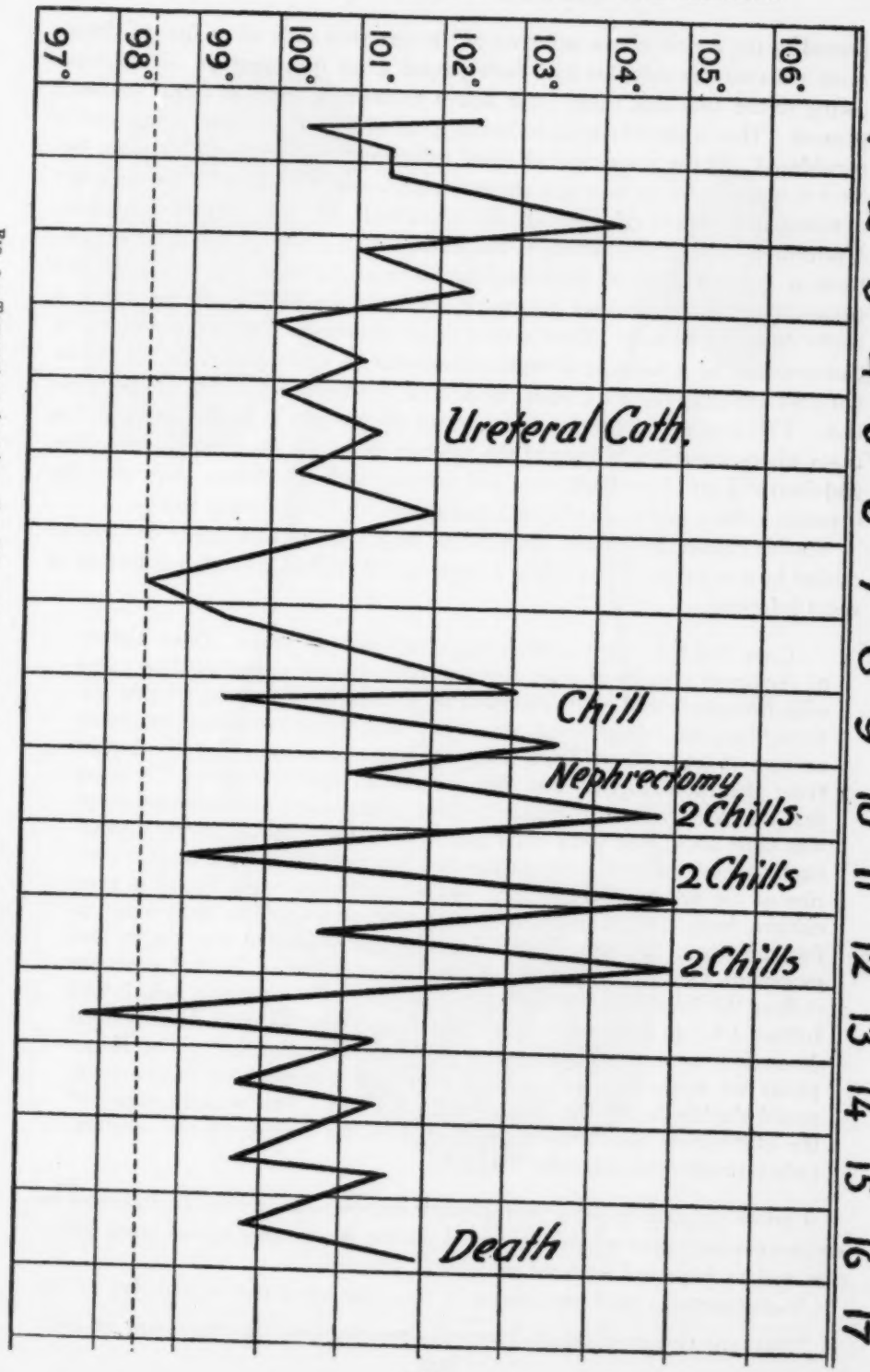


FIG. 9.—Temperature chart from Case V in which symptom of severe bacteræmia followed ureteral catheterization.

ported in the article above referred to,[3] it was very difficult at first to determine whether the calculus had been passed after the injection of albolene, owing to the fact that there were also a number of extra-ureteral shadows present. This is something to be borne in mind before operative treatment is considered. If the symptoms of renal infection are very acute, I do not believe it is advisable to take any chances with conservative treatment, if after a reasonable period of waiting, the symptoms of renal infection persist. Ureterotomy alone will suffice if the kidney is in good condition. Nephrectomy is imperative as an additional measure at the time of performing the ureterotomy if the various diagnostic methods referred to above reveal a badly damaged kidney. Even under these conditions it is often wise to be conservative, as a secondary nephrectomy can be easily performed if we do not wait too long for the clinical evidences of subsidence of the renal infection. This is especially true where calculi are present in both ureters and in cases where there is a history of the passage of calculi on previous occasions and finally if our functional tests and ureteral catheterizations show that the opposite kidney might possibly not be capable of doing double work.

In this connection let me quote a case which shows how easily one can be misled by a negative X-ray when a ureteral calculus is present in addition to renal infection.

> CASE V (No. 1333).—Male, aged thirty-three years. Gave history of recurrent attacks of right ureteral colic during preceding two years with hematuria and chills followed by profuse perspiration. Upon entering hospital temperature was 102°, and urine contained moderate amount of pus. Two X-ray examinations were made, but the report from the radiographer was that no calculi were present. Thinking that the case was one of renal infection alone, a ureteral catheterization was done about one week after entrance to the hospital during a practically afebrile period. An obstruction was met with in the lumbar portion of the ureter. Streptococci and staphylococci were found in pure culture from both sides. Indigo-carmine appeared on both sides in five minutes. A diagnosis of bilateral renal infection was made, and expectant treatment advised. Much to our surprise, he had a severe chill on the fourth day following the ureteral catheterization, which was followed by an extremely septic condition (Fig. 9), and death eleven days after ureteral catheterization. Upon reëxamination of the X-ray plates we found that the radiographer had overlooked a faint, small, round shadow in the line of the lumbar ureter. This was the cause of the obstruction which we encountered in the course of our ureteral catheterization on this side.

I quote the case to show that ureteral catheterization may be followed by serious consequences when performed during the acute stage of renal infection and an impacted ureteral calculus is present.

A nephrectomy was performed in this case after the second day of the

[3] Diagnosis of ureteral calculi. *Surgery, Gynecology and Obstetrics*, 1918, 27, 461.

FIG. 10.—Specimen removed at autopsy, showing calculus (UC) in lumbar portion of right ureter completely blocking same. Above point of impaction of calculus the ureter is greatly distended and the kidney is the seat of an extensive pyelonephritis. At lower end of the same ureter (Urc) were two calculi in close proximity to the ureter but lying in a congenital diverticulum of the bladder. The opposite (left) kidney was of a rudimentary type, so unable to do the work thrown upon it by the blocking of the right ureter.

onset of acute sepsis and the kidney showed the picture of an acute diffuse infection. Cultures taken showed B. coli alone. This case teaches the necessity of studying an X-ray plate, preferably a stereoscopic one in a dry condition, as faint shadows due to uric acid calculi may be easily overlooked.

In a recent case referred to in my preceding paper,[4] I was able to intensify such a shadow by injecting collargol into the ureter, which was absorbed by the calculus, thus enabling us to see it distinctly.

GROUP III. CALCULOUS ANURIA CASES

These constitute an absolute indication for operative treatment unless non-operative delivery is immediately successful. I do not believe, however, that one should waste any time unless the anuria cases are seen in the first few days. The period of tolerance in calculous anuria, *i.e.*, before uræmic symptoms supervene, varies somewhat, and one cannot afford to take any chances by relying upon a fixed time for these fatal symptoms to appear. The average period of tolerance, *i.e.*, before uræmia supervenes, is six to eight days after the onset of the anuria, so that there is no justification at the present time for operating upon these cases before a thorough urological study has been made of the location of the calculus and the condition of both kidneys, since these cases may be easily taken to a hospital where such facilities are at one's disposal. This anuria, according to Cabot, may occur in one of four ways: (1) The blocking of both ureters practically simultaneously by calculi; (2) the blocking of the only ureter; this may occur in (*a*) cases of solitary kidney, (*b*) where the opposite kidney has never developed[5] or has been destroyed by disease, and (*c*) in cases of fused ureter with two kidneys; (3) by the blocking of the ureter of the better of two damaged kidneys with the occurrence of reflex anuria in the damaged kidney on the opposite side; (4) by the blocking of the ureter on one side with reflex suppression on the other side though the kidney is sound. This last-named class of cases is still in dispute.

GROUP IV. BILATERAL URINARY CALCULI

Here, I believe, it is best to try to deliver the calculus by non-operative means on both sides if such a procedure is possible before operation is considered.

Bilateral ureteral calculi alone without concomitant renal calculi occur so infrequently that it is best to consider the two together, and I believe the indications have been best given by Braasch[6] in a recent paper, as follows: (*a*) The kidney with acute complications should be operated on first; (*b*)

[4] Diagnosis of Ureteral Calculi. Surgery, Gynecology and Ostetrics, 1918, 27, 461.

[5] I reported a case of calculous anuria in which the opposite kidney was rudimentary and the only functioning kidney blocked by calculi in ANNALS OF SURGERY, 1908, 48, 703.

[6] Lithiasis with Bilateral Renal Involvement. Boston Medical and Surgical Journal, 1918, 178, 292.

without acute complications the kidney with the better function should be operated on first; (*c*) occasionally simultaneous bilateral operation is advisable.

CONCLUSIONS

Operative interference is indicated in the following cases:

1. When colics recur or infection persists after repeated attempts have been made to deliver the calculus by non-operative methods and there is practically no change in the location of the calculus.

2. When there are evidences of stricture formation following (*a*) the spontaneous expulsion of a calculus, (*b*) or its delivery by non-operative methods, or (*c*) after a ureterotomy (Case II).

3. When a fistula is present either (*a*) as the result of perforation of the ureteral wall by a migrating calculus, or (*b*) above a stricture (Case II).

4. When a severe degree of renal infection is present and the calculus is impacted in the ureter (Cases III and IV). Whether or not it is necessary to remove the kidney in addition to the ureterotomy depends on the degree of involvement of the renal pelvis and parenchyma. Some of these cases are complicated by a peri-ureteral or perinephritic abscess which will require immediate drainage.

5. Calculous anuria cases should be operated upon as soon as the diagnosis of the location has been made. The average period of tolerance is six days. If the calculus is located near the vesical end of the ureter an attempt to deliver the calculus by manipulation is worthy of a single trial, but one should not lose valuable time by postponing operative interference too long while such an attempt is being made.

6. In cases of either aseptic or infected hydronephrosis (uronephrosis) immediate operation is indicated. As a rule, the degree of dilatation of the renal pelvis is such that a nephrectomy is necessary. If pyelography can be done in such cases, it gives the best picture of the extent of destruction of the parenchyma.

7. Many of the cases in which an attempt has been made to save the kidney may be benefited by catheter drainage, as suggested by Caulk, or renal pelvic lavage.

8. The indications in cases of bilateral calculi are given in the corresponding group (see above).

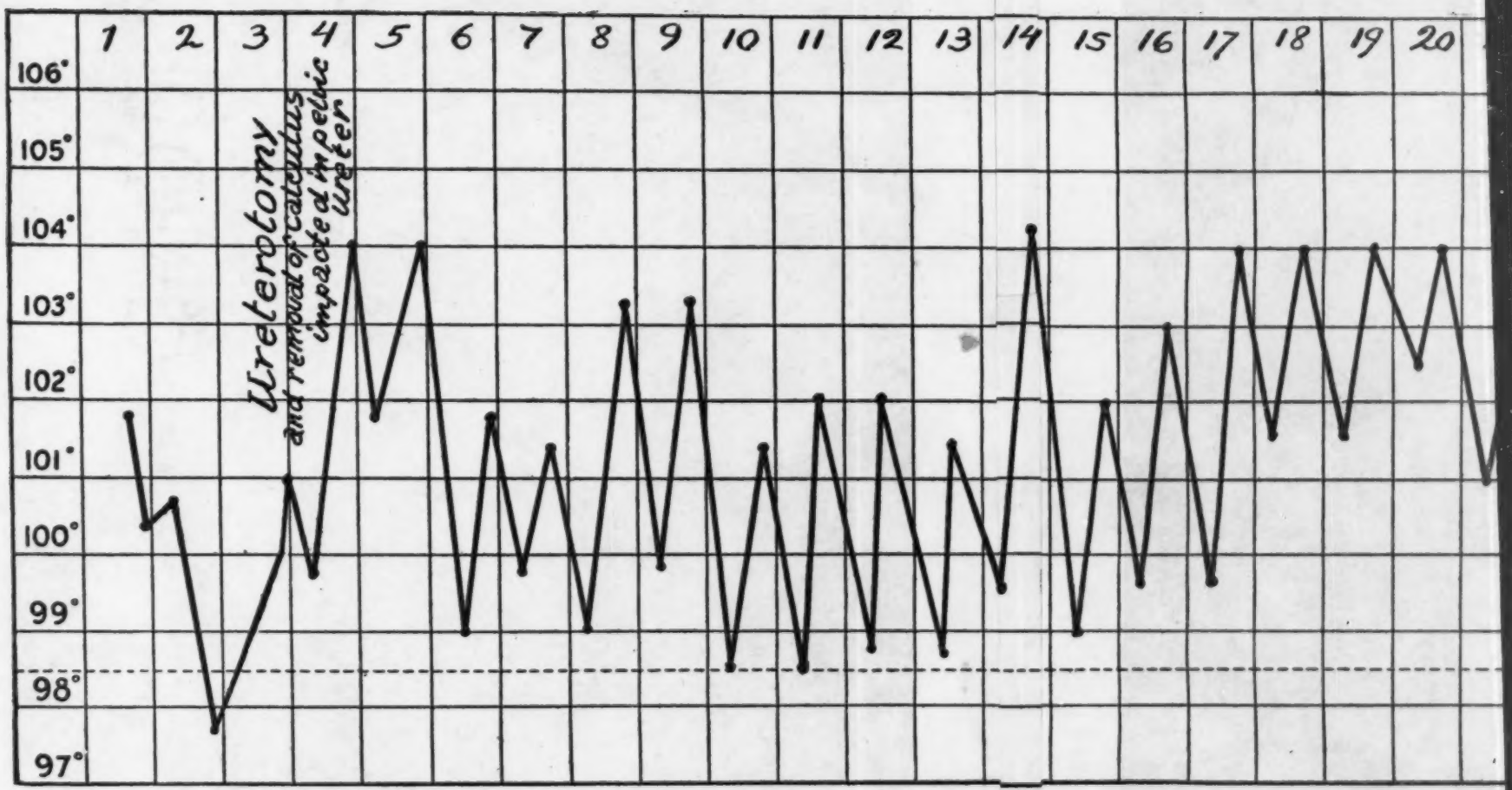
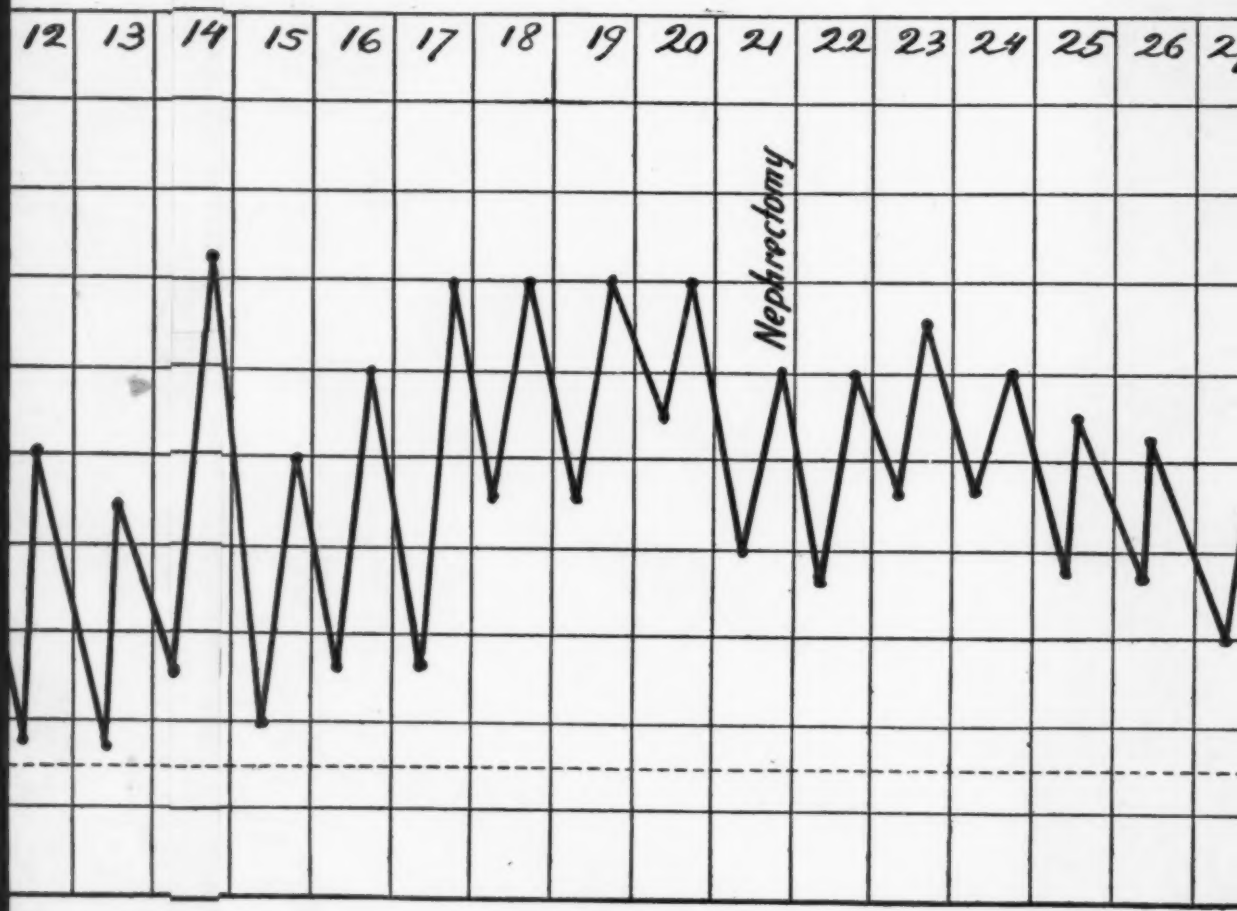
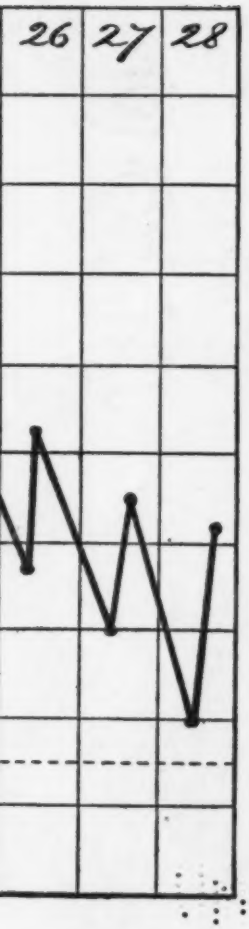


FIG. 8.—Temperature chart from Case IV, showing how fever persisted after removal of calculus, requiring later nephrectomy and drainage of perinep



ver persisted after removal of calculus, requiring later nephrectomy and drainage of perinephritic abscess.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SOME DIFFICULTIES IN THE DIAGNOSIS AND TREATMENT OF UNILATERAL RENAL TUBERCULOSIS

By Leon Herman, M.D.

of Philadelphia

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In employing the term Primary Renal Tuberculosis one refers to a state of primarity of the infection, only in respect to the site of its initial appearance in the urogenital system. The fact is well established that the several parts of this system are almost invariably infected by micro-organisms which are either blood-borne from some distant and truly primary focus, or more rarely by contiguity. In the vast majority of cases of tuberculosis of the genito-urinary system of the male, the tubercle bacilli find primary lodgment either in one or other kidney, or in the globus major of the epididymis. In these locations the bacilli find a favorable soil for development, which development proceeds in the majority of instances, to the formation of pathologic products, with a resultant clinical symptomatology that makes the case diagnosable before the disease has extended far from the primary focus. Rarely indeed does nature succeed in limiting the disease to such primary foci. If left undisturbed the bacilli spread to structures lying along the course of and in connection with the excretory duct of the organ primarily involved, the ducts themselves becoming, in the majority of instances, likewise diseased. Unfortunately, the major symptomatology of urogenital tuberculosis is expressive of the extension processes rather than the development of the disease at the point of primary lodgment of the bacilli. Patients therefore, especially those with renal tuberculosis, seek assistance at a comparatively late stage of the disease.

Tuberculosis frequently appears simultaneously in the male genital and urinary systems. This multiplicity of organic involvement implies a marked susceptibility of these particular structures to the disease, a fact that must be taken into account in advising operation. A complicating infection of the epididymis, tending as it does to spread along and infect the adenexa of and structures adjacent to the spermatic duct, further adds to the seriousness of a given case of renal tuberculosis for the reason that a lower urinary complication, primarily dependent upon the renal condition, may be continued after nephrectomy by the ascension of the disease from the epididymis, or by a direct extension to the bladder from a diseased vesicle or prostate.

For this reason, it is truly axiomatic to say that the prognosis in tuberculosis of the urogenital system is favorable in direct ratio to the degree of limitation of the disease in the structures primarily involved.

The tubercle bacilli usually find primary lodgment in the glomeruli situated in that part of the renal cortex which is nearest the medulla. The disease may remain localized to this point for a considerable period of time; it may spread and involve the greater portion of the kidney in a rapidly destructive process, or it may, by virtue of the ascendency of reparative processes, cause changes that result in total destruction of the renal parenchyma, notwithstanding which the disease remains limited to the kidney. Probably the universal surgical dictum, which demands nephrectomy in practically all cases of unilateral renal tuberculosis, is founded on that degree of existing ignorance which prevents differentiation between the small number of cases which would recover spontaneously from that far greater group in which from the beginning the disease is destined to progress to the ultimate death of the individual.

Tuberculosis of the kidney is peculiarly prone to remain localized to the upper urinary tract for a considerable period of time, but finally to spread to the bladder, and if left undisturbed, to attack the opposite kidney. In a series of 459 post-mortem subjects with the caseo-cavernous form of renal tuberculosis, Kelly and Burnam ("Diseases of the Kidney, Ureters and Bladder," 1914) found the disease localized to one kidney in 253 ($55^{1}/_{10}$ per cent.) instances. Furthermore, Kelly has confirmed Israel's statement that in only nine per cent. of patients who come for examination with tuberculosis of the kidneys is the disease bilateral. Complete limitation of the disease to the kidney in cases which come for operation, is comparatively rare, according to Kelly—34 per cent., an estimation, which so far as the male is concerned, seems to us most generous. In the great majority of males, the primary cystoscopic examination demonstrates involvement of the ureter, together with that portion of the bladder wall immediately adjacent to its orifice. Bladder involvement with ulcerations at points distant and separate from the ulceration surrounding the meatus of the ureter, signifies unusual susceptibility of the bladder mucosa to tuberculous infection and has grave prognostic meaning. This is well illustrated by a series of sixty-four cases of unilateral renal tuberculosis, complicated by vesicle involvement and reported by Kelly of which only nineteen remained well after operation. Contrast this with 100 per cent. of cures in a series of thirty-four cases reported by the same writer, in which the disease was limited to the kidney. Therefore, time reckoned on the destructive progress of the disease is of the greatest importance in devising treatment and estimating the prognosis.

Secondary deaths following nephrectomy for unilateral renal tuberculosis are due, in the majority of instances, to extension of the disease with ultimate involvement of the opposite kidney. In a not inconsiderable proportion of cases, the relief of bladder symptoms after operation is shortlived and life is little, if at all, prolonged. Grave doubts as to the propriety of operation accompany the postoperative observation of a

proportion of cases, and, notwithstanding the fact that nephrectomy in the treatment of unilateral renal tuberculosis has no worthy alternative, the fact remains that surgeons continue to ask themselves whether something more or something less could not have done, or left undone in a certain percentage of cases. We will attempt to illustrate by case reports, certain instances under which such self-questioning might arise.

Surgeons agree that unilateral renal tuberculosis calls for nephrectomy, but the disposal of the concomitantly diseased ureter is not governed by any universal rule of practice. To remove the ureter when it is unnecessary to do so, is probably less unfortunate than to leave it behind, when, as events subsequently prove, it should have been removed. Illustrative of this latter contingency is the case of:

Mrs. T., aged twenty-four years, an Italian woman, was admitted to the Methodist Episcopal Hospital of Philadelphia, in October, 1916, on the service of Dr. Wm. R. Nicholson. This patient had been suffering with the usual symptoms of urinary tuberculosis for a period of nine months. Pain in the left loin space was a prominent symptom. The left kidney was easily palpable and freely movable, but neither markedly enlarged nor tender. Tenderness, however, was elicited on deep pressure in the left inguinal region. A much thickened and tender left ureter was palpable per vagina. On October 5, 1916, a cystoscopic examination was made by Dr. Geo. Outerbridge, who reported his findings as follows: "Congestion and erosions in the region of the left ureter; cloudy fluid obtained per catheter from the left ureter in a rapid flow suggestive of pelvic retention. Normal urine obtained from the right kidney. Diagnosis: Infected left kidney, probably tuberculosis, with moderate dilatation of the renal pelvis."

The patient was then transferred to the surgical service of Dr. Jas. Baldwin, who asked me to make a cystoscopic examination. The findings confirmed the previous findings. Both kidneys were functionally active. Indigo-carmine, given intravenously, was eliminated from the right kidney in three minutes and from the left kidney in four and one-half minutes. The left ureteral pelvis was slightly dilated, its capacity being 15 c.c. The urine from the left kidney contained pus, that from the right kidney was normal. Sterile cultures were obtained from both specimens of urine. Guinea-pig inoculations were made with negative results and tubercle bacilli were searched for in the urine but none were found. On November 11, 1916, Doctor Baldwin (with whose permission the case is reported) removed the left kidney and the abdominal portion of the ureter. The latter was enlarged, soft and boggy, and evidently the seat of an active tuberculosis. The kidney was moderately enlarged and showed a general chronic miliary tuberculosis with beginning caseation and cavity formation. The pelvis of the ureter was moderately dilated and its walls were much thickened.

This patient had a long convalscence with the eventual formation of a chronic sinus, to cure which it became necessary to subsequently remove the remaining segment of the ureter.

This form of rather generalized chronic miliary tuberculosis of the kidney and ureter, which causes an enlargement of the kidney of moderate degree, and an enlargement, softness and bogginess of the ureter, together with tuberculous periureteritis, is an indication for total removal of the ureter, or at least its removal to a point well below the limits of its grossly apparent involvement. This type of ureteral infection is probably not a descending one in all instances, but the involvement of the ureter may occur concomitantly with that of the kidney and, like the infection of the latter, may be blood-borne. Whether the total removal of a tuberculous ureter of this variety should be done as a primary procedure, or whether the proximal end should be attached to the incisional margin, as advised by Mayo for certain other types of diseased ureters, with secondary removal if necessity demands, is perhaps an open question.

It is reported from the Mayo Clinic that less than five per cent. of the ureters in tuberculosis of the kidney require removal. "These," Wm. H. Mayo (*Surgery, Gynæcology and Obstetrics,* 1912, p. 93) says, "are usually cases in which a stricture exists in the lower portion of the ureter, close to the bladder, so that there is more or less retention on that side." In a second group of cases, comprising those in which the diseased kidney is functionally active and where there is a mixed infection present, sewing the stump of the ureter to the lower end of the incision is employed as an alternative measure to its complete primary removal. Rarely, in the Mayos' experience, is it necessary to remove the remaining segment of the ureter secondarily to cure a persistent sinus. The enlarged pipestem ureter whose walls have undergone what may conveniently be called eccentric hypertrophy, is generally left undisturbed in the absence of infection. Ureters of this type, when possessed of an enlarged lumen which is in free communication with the bladder through a so-called golf-hole ureteral meatus, should be removed completely. Certainly is this true in the presence of secondary infection. If the uretero-vesical valve is functionally normal, these rigid ureters may probably be retained with safety in the absence of a complicating secondary infection.

The several gross types of tuberculous kidneys develop independently of the physical state of the ureter. Nevertheless, the pre-operative determination that the kidney is non-functioning and its ureter closed as the result of inflammatory changes, will comfort the operator in those cases where subcapsular nephrectomy becomes necessary. Under these circumstances the ureter need not be disturbed. In cases complicated by large perirenal collections, the ureter should probably not be disturbed if one can be reasonably sure that it is undergoing or has completed a process of inflammatory obliteration. From the study of patients whose

convalescence after nephrectomy for unilateral renal tuberculosis has been complicated by persistent sinus formation, or continued bladder infection due to retained segments of the ureter, and from the published opinions of various surgeons, we may classify the cases in which total removal of the ureter is indicated as follows:

(1) Those cases in which the ureter is strictured below, dilated above and secondarily infected.

(2) Those cases in which the ureter is dilated, infected and in free communication with the bladder cavity.

(3) Cases in which the ureter is enlarged, soft and diffusely involved in a subacute miliary tuberculous process. The complete removal of ureters otherwise involved pathologically is, with certain exceptions, to err on the side of doing unnecessary work. With the exceptions just given, which comprise a surprisingly small number of the total, the ureter should either not be disturbed at all, or only such part of it should be removed as can conveniently be reached through the ordinary nephrectomy wound.

Some unfortunate mistakes are made in connection with unilateral renal tuberculosis, through a failure to recognize the renal lesion in the presence of a complicating genital infection. This occurred in the case of:

> J. G., aged twenty-seven years, was referred to the writer from Atlantic City in April, 1916, suffering with acute inflammation of the left epididymis. The gonococcus was found in urethral smears and in pus removed from the epididymis. The epididymotomy wound failed to heal and he returned seven months after the operation with a scrotal sinus. His urine was found at this time to be laden with pus. The epididymis on the operated side was found to be indurated and nodular throughout. The prostate gland and seminal vesicles were not grossly diseased. Careful questioning disclosed an ancient history of cloudy urine and bladder symptoms, antedating the beginning of the ureteritis and epididymitis. Cystoscopic examination demonstrated the presence of an infected and functionless left kidney and a normal right kidney. The normal kidney excreted indigo-carmine (intravenous) in seven minutes, while its diseased fellow failed to excrete any of the dye during a half-hour period. The total phenol-sulphone-phthalein output (intramuscular) was 27 per cent. All attempts to recover the tubercle bacilli from the urine failed. The X-ray showed a large shadow in the region of the left kidney. The patient refused operation at this time, but I have since learned that the left kidney was later removed and that the patient has now completely recovered.

A very early tuberculosis of one kidney may be overlooked in the presence of a more obvious non-tuberculous lesion of its fellow of the opposite side. This apparently is what occurred in the case about to be described. This patient, however, may or may not have had an early tuberculosis at the time of the first operation. Certainly the examination

failed to disclose any real evidence of the presence of tuberculosis, but it is entirely probable that the operation of nephropexy, which was done for ptosis of the opposite kidney, threw an additional strain on the supposedly healthy left kidney, which latter was, in reality, harboring a latent focus of tuberculosis. This case is reported with the kind permission of Dr. John B. Deaver and Dr. Wm. H. MacKinney:

> H. H., aged twenty-six years, was admitted at the Lankenau Hospital in September, 1917, suffering with pain in the left lumbar region. The initial attack of renal pain came eight years before the beginning of her present trouble and was followed by great frequency of urination. She recovered promptly, however, and was perfectly well for six years when an attack similar to the initial one began. She again recovered promptly and was well until a short while before her first admission to the hospital. Physical examination at this time revealed nothing remotely suggestive of renal tuberculosis, but the right kidney was ptosed and movable. Nephropexy was done and the appendix was removed. She recovered promptly and was entirely well for a period of two months, when intermittent hæmaturia made its appearance. Eight months from the time of the first operation, she was readmitted to the hospital. A cystoscopic examination was made (Doctor MacKinney) which disclosed the presence of ulcerations around the orifices of both ureters and on the trigone. Functional studies of the kidneys were made and showed markedly diminished secretory power on the part of the left kidney. Urine obtained from the left kidney was found to contain a great deal of pus. The right kidney was functionally normal. The left kidney was exposed and its surface was found studded with tubercles. It was removed, together with the abdominal portion of the ureter, and the patient made an uneventful recovery.

Primary tuberculosis of the bladder is undoubtedly a clinical entity but the condition is an extremely rare one. Not infrequently, a primary renal lesion is so limited in extent and so few and indefinite are the signs and symptoms to which it gives rise, that its presence is undeterminable in the study of an obvious vesical tuberculosis to which it has given rise. In the case about to be described, the pre-operative cystoscopic studies by Doctor MacKinney suggested the presence of primary renal tuberculosis. At operation, Doctor Deaver (with whose permission the case is reported) found nothing abnormal in the surface appearance of the kidney. He then incised it and the cut surface was also normal in appearance. The wound in the kidney was then sutured and the organ replaced. The patient made a rapid and complete operative recovery, but no record has been obtained of the subsequent course of the disease.

> Mrs. S. P., negress, aged thirty years, was admitted to the Lankenau Hospital on October 22, 1917, complaining of burning on

urination and pain in the upper abdomen and back. The cystoscopic examination disclosed the presence of ulcerations typical of tuberculosis. Both ureters were catheterized and found to be unobstructed. Indigo-carmine was eliminated from the right kidney in seven minutes, but none came from the left side in fifteen minutes. The left kidney was exposed, incised, but nothing abnormal could be found. It was then sutured and replaced and the wound closed.

The foregoing case is either an example of that extremely rare condition, namely, primary vesical tuberculosis, or what is probably quite as likely, an instance of localized renal tuberculosis the site of which escaped detection, notwithstanding the thorough search made for it. This latter is the viewpoint held by Doctor Deaver, who operated upon the case. The diminished renal function in this case, as was indicated by the slow and incomplete elimination of indigo-carmine, suggests the kidney as the primary focus of disease in this instance, or at least an involvement of the kidney in the diseased process. We believe personally, that minor degrees of lost renal function can best be determined through differential studies of the percentage output of phenol-phthalein, although the evidence furnished by the indigo-carmine test in the case just quoted, seemed most conclusive. In cases where the shadow of a doubt exists regarding the state of renal function, it would seem the part of wisdom to employ both of these valuable adjuncts to diagnosis. We have lately made the interesting observation that the excretion of indigo-carmine is sometimes greatly delayed under ether anæsthesia, thus in a recent case of tuberculosis of the left kidney and bladder (referred by Dr. Jas. Talley) the excretion of indigo-carmine from a normal right kidney was delayed for a period of twenty-nine minutes, the patient being under ether anæsthesia; this same kdiney excreted 40 per cent. of phthalein (intravenous) in a half-hour period and 65 per cent. of phthalein (intramuscular) during a period of two hours. During the first twenty-four hours, after removal of the tuberculous left kidney, the remaining kidney secreted thirty-four ounces of urine. To have depended solely on the indigo-carmine tests in this particular case, would have led us far astray of the true conditions present. To determine quantitatively the secretory activities of the kidney it is sometimes necessary, not only to employ the several functional tests, but to repeat these tests until the normal average of functional power of the kidneys can be ascertained.

FIBROMA OF THE TESTICLE

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Malignant tumors and teratomata of the testis are not particularly uncommon; but benign tumors, especially fibromata, are indeed rare findings. The various text-books on pathology dismiss the subject by stating that it may occur, but is exceedingly uncommon. The writer may be justified, therefore, in presenting the following report and discussion.

Mr. E. P. (History No. 12833), thirty-three years of age. Admitted to Mt. Carmel Hospital July 17, 1918, service of Dr. C. S. Hamilton and Dr. E. C. Brock, on account of a painful swelling of left testis.

Present Illness.—On June 5 (12 days previous to admission) the patient fell on a bar in such manner that the left testicle was pinched. The organ gradually increased in size, up to the time of admission. The swelling was accompanied by pain, and the patient had to give up his occupational activities.

Personal History.—Patient had mumps about fifteen years ago, and both testes were slightly involved. The right testis returned to normal size in due time, but the swelling on the left side has persisted ever since. Patient had "black" measles eight years ago, with resultant "weakness" of eyes. General health has been good. When admitted the left testis was greatly enlarged, measuring about 12 by 6 by 6 cm. The mass is very firm, and feels roughened or corrugated. It does not transmit light. The enlarged testis was removed by Dr. E. C. Brock. Examination of the mass removed showed a neoplasm associated with the tunica, also a small nodule separate. The patient made an uninterrupted recovery, and left the hospital ten days later.

Report of Pathologist.—Gross examinations: The mass measures 12 by 6 by 6 cm. It is very firm and covered with fibrous adhesions. On section one finds near the middle of the mass, the testicle proper, slightly larger than normal, measuring 6 by 3 by 2 cm. (Fig. 1 a). About four-fifths of the surface of the testicle is smooth and free. A narrow zone on the anterior surface, about 4 mm. wide, and running the entire length of the testicle marks the attachment of a fibrous growth (Fig. 1 x). This new growth extends around the testicle so as to completely surround the organ. The least thickness of the neoplasm is found at the line of origin, and measures 4 mm. From this point the tumor grows progressively larger until it reaches a maximum thickness of 4 cm. on the other side of the testis. The new growth is completely encapsulated. On the posterior side of the testis is the attachment of another firm, fibrous, encapsulated nodule 12 mm. in diameter. This nodule appears to have developed entirely independent of the larger growth. The points of origin of the neoplasms appear to be in the tunica albuginea, which is

FIG. 1.—Gross appearance.

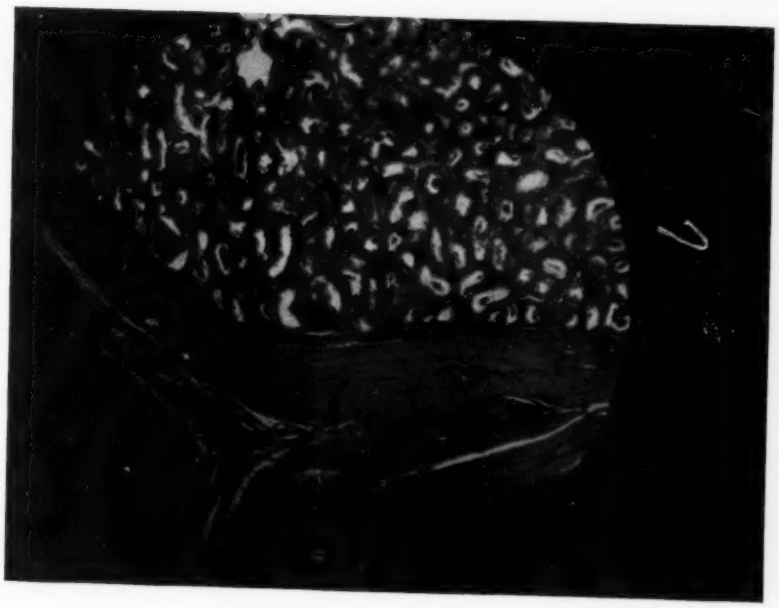

FIG. 2.—Microphotograph showing origin of tumor at X.

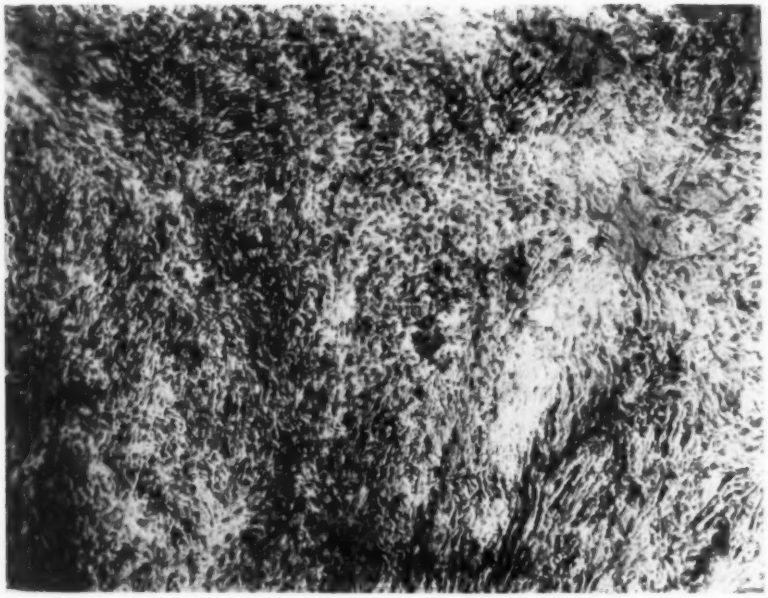

FIG. 3.—Microphotograph showing richly cellular areas.

FIG. 4.—Microphotograph showing less cellular areas.

sharply demarcated from, yet densely adherent to, the tumor. There is no evidence of calcification or cyst formation.

Histopathology.—The parenchymatous tissue of the testis is of normal appearance. Within the tubules one finds the usual cells, etc. The portion of the tunica albuginea that is not in contact with the new growth presents a normal appearance. One finds the usual connective tissues and capillaries. The area of the tunica in contact with the neoplasm presents a different appearance (Fig. 2 x). Strands of fibrous connective tissue of the tunica have grown outward, beyond the usual boundary. Productive proliferation and persistent growth have caused the formation of the tumor mass. The tumor mass is composed of fibrous tissue, which contains many proliferating fibroblasts. Blood capillaries are unevenly distributed throughout the tumor. Round cell infiltration is not found. Fibroglia fibrils are present, but there is a great excess of collagen fibrils. Some areas are richly cellular (Fig. 3), the nuclei staining deeply with hematoxylin. Mitotic figures are found, and the general appearance is slightly suggestive of sarcoma. Other areas are less cellular (Fig. 4), and contain more collagen; the fibroblasts are older; and there are fewer mitotic figures. There is nothing indicative of teratomatous origin.

Diagnosis.—Fibroma of the testis.

Discussion.—There is presented here a fibroma which has developed from the tunica albuginea. The most marked feature of the tumor is its large size and the great rapidity of its growth. According to the history, this hard mass had formed in twelve days. That such a firm fibrous growth could occur within two weeks seems highly improbable, yet how else may we explain its appearance? As a result of mumps, fifteen years previous, the testicle was swollen and had remained so ever since. Was this enlargement the true beginning of the fibroma, or did it contribute, in some obscure way, to the later formation of the neoplasm? Or was the tumor the result of the traumatic injury of recent date? We do know, however, that the major portion of the growth was actually produced within the twelve days.

Although the neoplasm completely surrounded the testis, and *produced pain,* yet there is no evidence of pressure atrophy of the organ. Due to these puzzling factors the clinical diagnosis was withheld.

A NEW OPERATING COMPOSITE CYSTO-URETHROSCOPE

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Owing to many difficulties to be overcome in urethroscopy, I had, in 1911, devised a urethroscope operated by air distention and provided with a megaloscope, which turned on hinges from side to side, thus allowing space for intra-urethral manipulations. The picture obtained by its use was clear, well defined and magnificently enlarged. Its outstanding features were particularly noticeable in the examination of the anterior and membranous urethra, where a concentric view is desirable. Its utility was no less apparent in the prostatic urethra and at the internal

Fig. 1.—Endoscopic tube, straight end.

vesical sphincter. The visual and operative field is much larger in the prostatic urethra when viewed through this than through any other instrument.

In the last two or three years, I used in some cases the same instrument, with water as a distending medium, but without any magnifying system. Then, after acquainting myself with the work of Luys, in which he speaks of dilating and catheterizing the ejaculatory ducts for diseases of the seminal vesicles, I set out to construct an instrument, a modifica-

Fig. 2.—Endoscopic tube, end opened on 45° angle.

tion of my old model, by means of which it would be possible to accomplish it without great difficulty and without undue traumatism of the tissues.

When constructing the instrument, I bore the following principles in mind: First, to obtain a concentric view of the anterior and posterior urethra; particularly, is this important in incipient prostatic enlargement, which can but with great difficulty be made out with the average rec-

tangular cystoscope; whereas, when looked at directly from the posterior urethra, the entire sphincter stands out in bold relief, and can be studied in relation with the prostate, and the distance of the colliculus from the sphincter; secondly, when the tissues in the posterior urethra are bleeding, clots of blood usually adhere to the telescope and lamp, thus obstructing the view, or causing a false interpretation of the picture, an annoyance which can be cleared up only by removing the telescope and washing it thoroughly; and while doing this, one often dislodges the instrument, and

FIG. 3.—Endoscopic tube.

loses the field under observation. Then, again, in the membranous urethra it is of advantage to get a concentric field, for with the prismatic type of urethroscopes, the lens being so near the tissues which are less dilatable than either the prostatic or anterior urethra, it is, in a considerable number of cases, impossible to get a true picture of the lesion. It is needless to say, that, in the anterior urethra, not only is a concentric view desirable for an accurate diagnosis, but that an instrument giving

FIG. 4.—Window for operative work.

FIG. 5.—Window for water dilatation with lens.

such a view is easier of manipulation, both for inspection and treatment. Another important point to bear in mind is that, when the tissues are kept on a stretch by a fluid medium, particularly when viewed through a prismatic system of lenses, they are paler and are accompanied by a certain amount of distortion of the image, thus endangering a false interpretation, in addition to having a less illuminated field owing to a considerable amount of light absorbed by the lens system. It is obvious,

FIG. 6.—Straight obturator.

then, that urethroscope which can be used with water and air at the same time, thus comparing the differences in appearance under air and fluid, will be more serviceable both for an accurate diagnosis and for appropriate treatment.

No less important is the disinfection of intravesical and intra-urethral instruments by heat rather than by chemical antiseptics, especially when a number of patients have to be examined in succession.

In compliance with the foregoing principles, I had the Kny-Sheerer Corporation construct a urethroscope which I shall describe in detail. It consists of three tubes, each 17 cm. long and 25 mm. in circumference; one straight tube with a straight obturator for the anterior urethra; one straight tube, the distal end of which is cut off at an angle of 45°, provided with a special obturator, which may be bent or straightened at the

FIG. 7.—Posterior obturator.

distal end by pressing or relaxing the proximal end of the obturator; and, lastly, a straight tube, whose distal end is cut off at an angle of 30°, used for the posterior urethra, and giving a larger operating field. The proximal end of the tubes is provided with stopcocks for irrigation and air distention. It is, furthermore, provided with two light carriers, one of which is used for inspection and topical applications and other operative

FIG. 8.—Light carrier with double end ground fitting for endoscope.

procedures in the urethra and the bladder; the other light carrier is combined with a deflector, having one catheter channel for the introduction of No. 5 bougies and catheters to be used in connection with utricle, ejaculatory ducts and ureters. The outstanding feature of this deflector is that the farther end does not come in contact with the verumontanum or any of the other tissues, thus sparing them from injury and its concomi-

FIG. 9.—Attachment for catheterization with lens, light carrier and lever operating catheter guiding fingers.

tant annoyances, and facilitating the introduction of bougies into the utricle, ejaculatory ducts and follicles, a manœuvre which I tried repeatedly with the indirect catheterizing and direct vision cystoscope, with little or no success, due to the fact that the field of operation in the urethra is limited to such an extent that when the deflector of the ordinary cystoscope is used, the distal end of it coming in contact with the tissues, causes so much bleeding as to obscure the field of vision; and in case of

the colliculus, pushes it out of the way, and flattens it to such a degree that operation is impossible; while with the direct vision cystoscope the catheter is lost in space.

The magnifying system consists of two sets of observation lenses, used for air and fluid, respectively. They are fastened, at will, to the proximal end of the light carrier, which facilitates the interchangeability of the water and air lenses, and thus makes it feasible to change from fluid to air media, without disturbing the instrument or losing the field under inspection. Next come two operating windows for air and fluid respectively. They are provided with perforated hoods, which can be tightened or relaxed, and serve for the introduction of various instru-

FIG. 10.—Tube for aspiration and bulb.

ments through them into the urethra and the bladder. The lens for the deflector is permanently fixed to it, it being used exclusively with water medium, for the reason that virulent germs may be prevented from being carried into the ejaculatory ducts, an accident which might frequently happen if air instead of fluid were used; whereas, if a fairly strong antiseptic solution, such as oxycyanide of mercury 1:5000, a solution which I used exclusively in the last eight years in all my cysto-urethroscopic work, is used, such accidents may then, in the large majority of cases, be forestalled.

The following accessories are used with this instrument: An aspirator with a bulb, for removing fluid from the urethra; a cannula, fitting

FIG. 11.—Tube for guiding fil forms.

snugly into the operating window, for the introduction of flexible instruments into the urethra, such as bougies, catheters and filiforms; one universal handle for detachable knives, curettes and cotton carriers; one pair of alligator forceps; one snare; one cautery; one instillator with syringe; one fulguration handle. In the near future I hope to add an aspirating attachment for evacuation of stone fragments after lithotripsy.

Modus Operandi.—The urethroscope should, before use, be boiled; while the light carrier or deflector be sterilized in pure carbolic acid and rinsed off in alcohol. It is a great advantage to have a regular cystoscopic table with either Bierhoff's or Young's legholders, a table which can be raised or lowered without disturbing the patient; for it often, in the course of the examination, becomes necessary to change the position of the patient. The legholders should be so adjusted as to bring the knees of the

patient above a higher level than his head, while the table is raised about 30 to 40 degrees from the horizontal plane, in order to give the patient a slightly exaggerated lithotomy position.

The instrument table with all the instruments arranged is placed to the right of the operator; the source of light, whether from the street current or a hand battery, together with the irrigator, should for the convenience of the operator be placed to his right. The long rubber tube, conveying the solution to the urethroscope, may be supported by the patient's legs. A cut-off, to control the influx of the solution, is

FIG. 12.—Scissors.

necessary, but let no reliance be placed on a makeshift. The Esmarch cut-off is the best to my knowledge, and the one I used with a great deal of satisfaction. There are others, which are not so easy to handle.

Assuming the patient is, for the first time, to be examined, enough of his clothing be removed to enable him to adopt a lithotomy position, with his knees well supported, the irrigator having previously been filled with 1:5000 oxycyanide solution, and the rubber tubing being supported by the patient's left leg. The proper tube for the posterior urethra, preferably, the one from which a smaller wedge has been removed, with the beaked obturator, is introduced into the bladder containing about three ounces

FIG. 13.—Tube for catheterization and for mounting operative instruments.

of urine. If the bladder has been completely emptied, then three ounces of the solution should be injected into it prior to the introduction of the instrument. This applies to all other hollow instruments used for the bladder, as well. The reason is simple: When a hollow tube with an obturator is introduced into the hollow viscus, whose walls are collapsed and assume the shape of the letter Y, the trigone with the base of the bladder representing one limb, while the roof representing the other, and both converging to the internal sphincter, are sucked into the opening of the tube, when the obturator is removed. This causes a circular area of hyperæmia, which resembles a punched-out ulcer of the bladder, and may, by the unwary, be readily mistaken for one. This

accounts for many reported cases of ulcer of the bladder. There is no actual loss of substance, and it is but of an evanescent nature, the circulation being restored in a short while.

The proximal end of the obturator being held firmly between the thumb, index and middle fingers, the instrument is allowed to slide in gradually past the sphincter, the pressure from the proximal end of the obturator being released, when the obturator straightens out, becomes disengaged and easily dislodged from the urethroscope: it is then withdrawn. The examining lightcarrier is now attached to the urethroscopic tube, and the irrigating tube joined to the stopcock. The observation window is then fitted snugly to the urethroscope, the lamp connected with the electric current, and the water slowly turned on. As the water flows in, air bubbles are seen rising to the surface of the lens, partially obstructing the view. The air which accumulates

FIG. 14.—Curette.

FIG. 15.—Urotomy knife.

FIG. 16.—Cotton carrier.

on the under surface of the lens is allowed to escape by gently lifting the lens off the urethroscope, while the water continues to flow into the tube; then, the lens is reconnected with the urethroscope, when a perfectly lighted and clearly defined image appears at the distal end of the tube. As soon as the picture is clear, the current of water may temporarily be turned off. A systematic examination is now begun.

In order to obtain a good view of the trigone and the ureters, only about two or three ounces of fluid are required. They can be seen to the best advantage by lowering the table with the left hand of the operator to a horizontal position. To examine the other parts of the bladder, more distention is necessary, which can best be determined by experience. To get a good view of the roof of the bladder, the table should again be raised from the horizontal plane, and thus segment after segment be examined until the sphincter is reached. When in the course of the examination a little

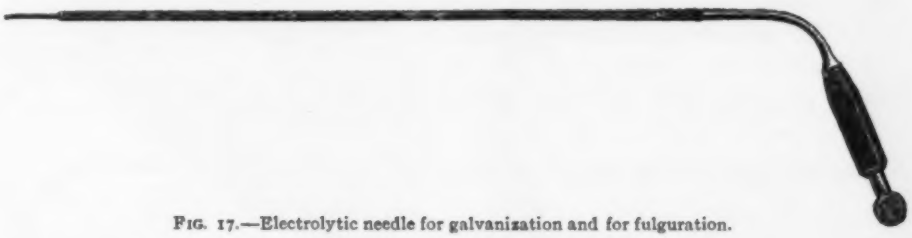

FIG. 17.—Electrolytic needle for galvanization and for fulguration.

film collects at the distal end of the tube, the water is turned on, a few c.c. of which are sufficient to clear the field. The posterior bladder wall, which is rather inaccessible to the usual indirect vision cystoscope, can be plainly made out by this instrument. The sphincter can best be seen by raising the table, and by gradually withdrawing the urethroscope into the posterior urethra, when the whole circular outline of it can be made out. This is of particular interest in connection with beginning prostatic adenoma.

By withdrawing the tube still further, the entire prostatic, membranous and anterior urethra is examined in turn. When in the course of urethroscopic examination the field gets blurred, the stopcock is again opened, and the solution is allowed to flow in, to wash out any secretions that obstruct the view.

When the prostatic urethra is inspected by this instrument, it may be seen in its entirety at one glance. All the walls are distended, the

prostatic fossæ are flattened out, the prostatic follicles are easily made out, and in many instances pus can be seen oozing out from them. The longitudinal folds, a continuation of similar folds of the uvula of the bladder, are plainly seen. Particular attention should be paid to them, since very often infected follicles together with fine thread-like polypi, are situated between them. The verumontanum stands out prominently in the floor of the urethra, and it may be seen in its entirety or in part, according to the angle at which the instrument is manipulated. The utricle is nearly always seen at or near the summit. Its outline should be carefully studied. It is often inflamed, having angry infiltrated edges and dis-

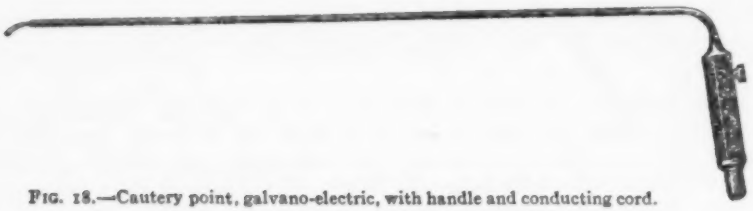

FIG. 18.—Cautery point, galvano-electric, with handle and conducting cord.

charging pus. In the average case, the ejaculatory ducts should be looked for at the extreme edge of the colliculus seminalis, on a plane with the utricle, though frequently they are located in the immediate vicinity, on either side of the utricle. When the colliculus is highly turgescent, then the central part of it bulges out and pushes the ducts to the extreme edge, so that they may be lost in the intense bogginess of the tissues. They may then be temporarily lost from sight to reappear after the subsidence of the tumefaction of the tissues. When one looks for them in the verumontanum of the cadaver, they are, in the large majority of cases, seen on either side of the utricle, due to the collapsed

FIG. 19.—Tube for application of medicaments of silver.

state of the tissues; and this is the usual location assigned to them by the various text-books of anatomy. When looking for them with this instrument, it is advisable to manipulate the urethroscope at different angles. After a few trials one becomes proficient in locating them.

As to the therapeutic value that may accrue therefrom, time alone will decide. I have introduced filiforms and No. 3 bougies into them in from 60 to 80 cases, practically all private patients, and for that reason I have been chary in aspirating and injecting the ducts, as I hope some day to do. From a little unpleasant experience that I had from using a filiform bougie for the ducts, though it led to no untoward effects, I

FIG. 21.—Showing urethral cavity, ejaculatory ducts and extremely large utricle.

FIG. 22.—Showing roof of urethra, lateral walls, utricle and ejaculatory ducts.

FIG. 23.—Showing normal ureter as seen by the cysto-urethroscope.

FIG. 24.—Showing normal base of bladder.

FIG. 25.—Showing polyp on summit of Verumontana.

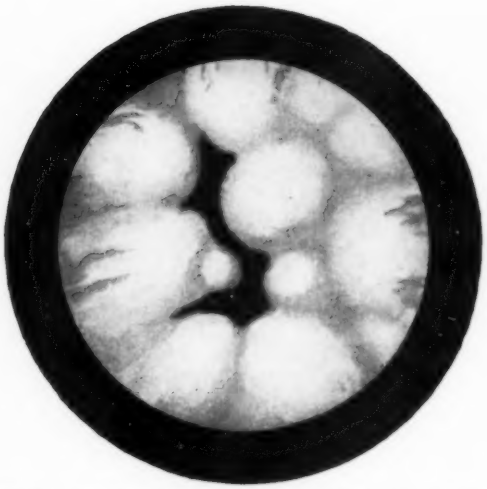

FIG. 26.—Showing cystic distention of glands in post-urethra.

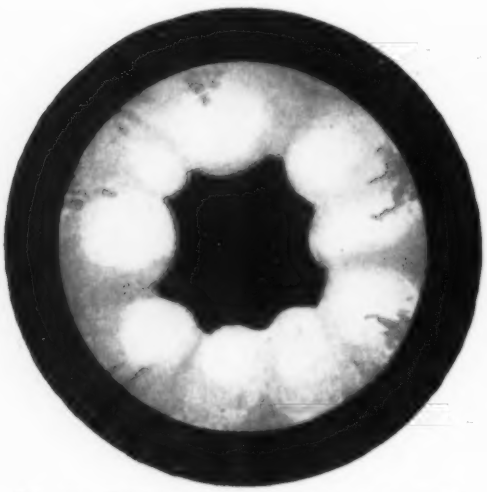

FIG. 27.—Showing sphincter—cystic glands around it.

FIG. 28.—Showing membranous urethra polyp on floor.

FIG. 29.—Showing humpbacked Verumontana.

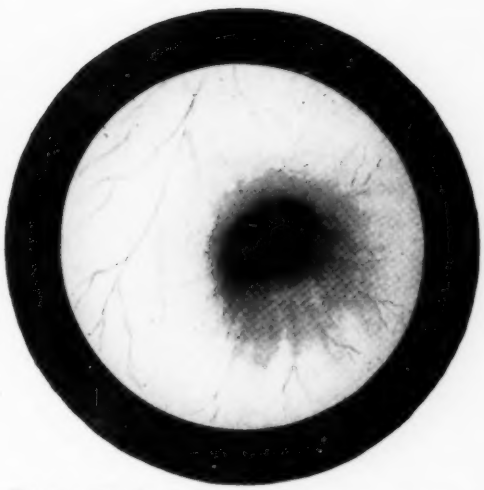

FIG. 30.—Showing diverticulum of posterior wall of bladder with congested edges, due to a stone lodged in there but passed two days before the examination.

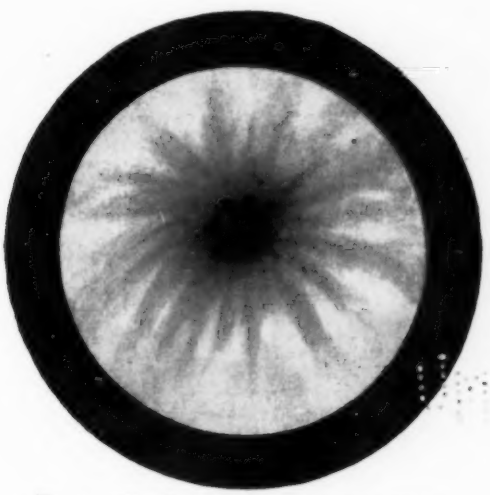

FIG. 31.—Showing normal membranous urethra.

should advise against its use, but to depend exclusively on the Nos. 3 or 4 silk bougies.

The case in question is a young sexual neurasthenic, who throve on urethral instrumentation. Accordingly, I introduced a filiform for a distance of one inch and a quarter into one of his ejaculatory ducts, when I called a truce and wanted to withdraw it. I suddenly felt a jerk, as one feels when trying to remove a sound from a tight stricture; I redoubled my efforts to extract it, when suddenly I felt a snap, and a part broke off. Fortunately that fragment was seen protruding from the opening, and I had no difficulty in extracting it with the aid of forceps. Since then I gave up the use of filiforms for that purpose, but I use silk bougies instead.

One practical lesson I learned from this experience, namely, that the ejaculatory ducts have a strongly developed circularly arranged muscular coat, which contracts spasmodically. It is not at all unlikely when

FIG. 20.—Alligator forceps.

considering the oblique route they take in the prostatic substance, and their configuration, being dilated above, near the seminal vesicles, and tapering in their descent towards the urethra, that by the contraction of their circular fibres, they assume a sphincteric action and prevent the leakage of the seminal secretions. It may, furthermore, explain the spasmodically occurring colicky pains in the perineum, reflected in various directions, as being due to distended and inflamed vesicles, the contents of which are under a greater pressure than normally, and in trying to escape into the urethra are impeded from so doing by powerful contractions of the ducts.

Twice I have seen an epididymitis develop, and in both cases only after repeated dilatations of the duct.

After the prostatic urethra has been gone over carefully, all the other parts of the urethra should, by gradually withdrawing the instrument, be thoroughly examined.

When in the course of an examination, one wishes to make direct applications to the urethra, he can easily do so by aspirating the fluid from the urethra through a special aspirator designed for that purpose;

under these conditions, the air window should be substituted for the other, in order to get a magnified vision.

After one familiarizes himself with the examining constituents of this instrument, he can easily make use of all the operative attachments, namely, the deflector and the perforated windows with their accessories, being guided by the principles as heretofore outlined.

This urethroscope is also available for the use of air as advocated by Luys, and Kelly, or by forcible distention with air through an air bulb.

The Kelly method is applicable in women with short urethræ, in whom the introduction of instruments is very simple in the knee-chest position.

Luys, on the other hand, treating mostly males, advises an extreme Trendelenburg position for his patients, being practically impossible to introduce an instrument into the male urethra in the genu-pectoral position. Only in exceptional cases does he resort to the knee-chest posture in the male, but he first introduces the instrument in the ordinary position, then he very cautiously turns him over in the knee-chest position.

When one finds it difficult to get sufficient air distention of the bladder by either of the two methods, then forcible inflation by means of a rubber bulb may be resorted to.

To sum up: This composite cysto-urethroscope has a wide field of application, both in the bladder and the urethra of the male and the female. Lesions in the posterior wall of the bladder are more easily accessible to this than to the rectangular vision cystoscope. Its simplicity of construction together with its ease of manipulation lends itself to various operative procedures in the bladder and the urethra. The deflector makes it possible to reach any part in the urethra without injury to the tissues. It is especially applicable for fulguration of tumors, inflamed areas in the urethra, and destruction of glands and cysts. The cautery may be used for the destruction of median prostatic bars, using air instead of fluid for a distending medium.

I append a few illustrations of normal and abnormal conditions of the urethra and the bladder as seen through this instrument and sketched by an artist at the examination table.

DUPUYTREN'S CONTRACTURE, WITH A DESCRIPTION OF A METHOD OF OPERATION

By A. Bruce Gill, M.D.
of Philadelphia, Pa.

The treatment of Dupuytren's contracture has long been tedious, difficult, and often unsuccessful. Even when temporary restoration of the hand has been secured, relapse has been common.

The author's experience, limited though it has been, in plastic surgery of the hand and forearm, has proved to him the great value of the free fat transplant in preventing adhesions after the excision of scar tissue and after extensive dissections. It has also demonstrated the advantage of making incisions along the line of the natural creases of the hand and fingers in order to secure healing of the wound without danger of subsequent keloid growth, contracture, and adhesion of the scar to underlying structures.[1]

This led the author to employ the following method of operation for Dupuytren's contracture:

(1) Under general anæsthesia, without the use of a tourniquet, a transverse incision is made along the distal palmar crease. Through this incision alone a careful dissection is made of the entire palmar fascia to or beyond the crease at the base of the thenar eminence, as far towards the base of the palm as is necessary, and to the web of the fingers. The skin is adherent to the fascia, and the dissection must be made carefully to avoid button-holing the skin. With proper retraction as the dissection proceeds it is found that the entire fascia can be exposed and freed within the limits mentioned.

(2) The contractured fascia is then excised without injury to the underlying tendons, vessels, and nerves. The tendons do not require lengthening as they do not participate in the contracture.

If contractured fascia is present on the palmar aspect of the proximal phalanges, it may be excised through transverse incisions along the crease at the base of each finger involved.

If now it is found that the proximal interphalangeal joint can not be extended, or that it can be extended and flexed again only with a snap, the head of the first phalanx must be excised through a transverse dorsal incision over the joint. Professor J. Hutchinson lays great stress upon the necessity of this procedure in long-standing cases. This is, of course, a familiar procedure to surgeons who are accustomed to operate on

[1] Plastic Reconstructive Surgery of the Hand and Forearm. Annals of Surgery, July, 1918.

hammer-toes or on fingers long held flexed by other causes than Dupuytren's contracture.

(3) A small free fat transplant from the thigh is inserted smoothly beneath the palmar skin. It will lie in position without sutures. It is placed here to prevent subsequent adhesion of the skin to the tendons and to reconstruct the normal softness and plumpness of the palm of the hand. The incision is closed with a few interrupted sutures of No. 0 chromicized catgut. The hand is dressed on a well padded splint for a week. Slight serous discharge may occur for a short time, which is probably due to some dissolution of the fat transplant. Infection from the outside may be prevented by the use of dichloramine-T on the wound at the daily dressings. Great care should be taken, of course, at the time of operation to avoid infection.

The following case will illustrate this method of operation:

CASE I.—J. C., a tool-cutter, was seen at the Episcopal Hospital on July 29, 1918. About the middle of June his right hand was injured in a machine. The palm was contused, but the skin was not broken. The injury was not sufficient to cause him to stop work. Thereafter he experienced soreness in the palm, particularly after working.

On examination there was present a marked thickening on the ulnar side which extended to the middle of the palm of the right hand. Active and passive extension of the little finger was limited to 160°. Massage was ordered.

On August 12 it was observed that the condition had spread since the first examination and that the little finger was flexed more acutely and that the ring finger was also partially contractured.

Later, on September 9, the contracture involved the palmar fascia as far as the base of the thenar eminence, and the contracture of the little and ring fingers was more marked.

Operation was performed on September 23, 1918, by the method described above. The entire palmar fascia was excised from its ulnar border to slightly beyond the crease at the base of the thenar eminence and from the base of the palm to the web of the fingers. It was unnecessary in this case to go beyond the web. A free fat transplant from the thigh was inserted beneath the skin, and the transverse incision was closed with a few interrupted chromicized catgut sutures. The hand was dressed on a palmar splint.

The wound healed, but ten days after the operation its outer portion broke down and discharged a small amount of serum for several weeks. No pus was present. It was dressed with dichloramine-T. Eventually the wound healed again, with a scar that is scarcely perceptible, with no induration in the palm or about the scar, and with normal motion of the finger.

The condition of the patient at the present time is as follows: The scar along the distal transverse crease can with difficulty be seen; the palm is soft and plump, but not unduly so, and the motion and function of the fingers are absolutely normal. The little finger

FIG. 1.—Hand of patient three months after operation, showing normal extension of fingers and absence of perceptible scar.

of his left hand has been amputated. A little over a year ago he developed a Dupuytren's contracture of his left hand for which he underwent seven operations in another hospital and eventually had the little finger amputated.

Dupuytren's contracture was described by Sir Astley Cooper, but it was first dissected by Dupuytren in 1831, who demonstrated that the condition is one of contracture of the palmar fascia alone without involvement of the flexor tendons. Sir Robert Jones defines it as a fibrositis of the palmar fascia not associated with any inflammation thickening of the skin.

Pathologically there is a thickening and contracture of the digital processes of the palmar fascia primarily and of the main body of the fascia secondarily. In extreme cases the interphalangeal joints may become partially dislocated. Microscopically the fascia is found to consist of fibrous bands with cellular infiltration characteristic of a plastic inflammation.

The palmar skin is puckered and usually is closely adherent to the fascia.

There have been two theories as to the etiology:

(1) That the contracture is due to external agencies such as acute injury to the palm or oft-repeated stresses; (2) that it is constitutional in origin. Keen, Adams, and Anderson, three leading writers on the subject, lay more stress on the second theory. Sir Robert Jones thinks the cause is probably a predisposition in an individual with palmar irritation as an exciting cause. Kenneth Black, to whose comprehensive article in the *British Medical Journal*, 1915, 1–326, the reader is referred, states that he believes it will eventually be recognized to be due to a certain internal condition (possibly akin to gout or rheumatism) among persons of advancing age.

The case which I have reported above occurred in a healthy young adult as the result in each instance of injury to the hand. But we cannot deny, of course, that some predisposing internal condition was also present, although he presented no rheumatic or gouty tendencies.

Two methods of treatment of Dupuytren's contracture have been employed; the non-operative, and the operative. Among the former may be mentioned the long continued use of splints, massage, and manipulation, the use of fibrolysin, ionic medication, X-ray treatment, and the internal administration of thyroid extract. These may all be dismissed as of no value.

Dupuytren advocated an open transverse incision and allowed the wound to heal by granulation. This method would not be employed by modern surgeons.

William Adams practised subcutaneous division of the fascia followed by long continued use of splints. This method is open to the objections

that it frequently fails entirely to relieve the condition, that relapses occur, that it occupies a long period of time during which the patient is unable to work, and that permanent stiffening of the fingers not infrequently results from the long splinting.

Paul Berger employs a wide excision of the skin and fascia and a transplantation of a skin flap from the chest. Professor J. Hutchinson says that this method has nothing to recommend it.

The remaining methods of operation have consisted in excision of the fascia by means of various flaps or longitudinal incisions. Kenneth Black says that " skin flaps are dissected from the palmar fascia, the fascia is excised, and the wound is closed. Greatest care in asepsis must be observed, for if the wound suppurates the operation will fail and the resulting contracture will be excessive. The operation is not easy, it requires patience. Dissection of the skin from the fascia is troublesome, and the excision of the fascia from the tendon sheaths must be done bit by bit. Then splints must be employed for weeks."

Professor J. Hutchinson—Hunterian Lecture, *Lancet*, 1917, 1–285—in one of the most recent articles on this subject states that: "(1) The main incision should be linear and vertical over and closely parallel to the ridge of palmar fascia. Small transverse incision at the front of the web may be needed to excise any prolongation of fascia in front of the first phalanx. (2) In the case of the middle and ring finger it is impossible to avoid placing the incision towards the mid-palm. In the case of the little finger alone the incision may be made rather to the ulnar side of the hand where the skin is more supple and less subject to pressure." He adds that V- and Y-incisions are no good as they cause too much scarring of the palm.

The advantage of an incision along a transverse crease of the palm is too evident and too well known to surgeons who have operated upon the hand to require discussion. The same principle applies to surgery in any portion of the body; an incision along a natural crease of the face, or the neck, or the elbow, or the wrist will occasion much less scar, keloid overgrowth, or contracture than an incision transverse to the creases. But I do not find in a search of the literature that any writer has advocated the use of such an incision for the excision of the palmar fascia. That the operation through such an incision is not unusually difficult is demonstrated in the case presented before you this evening.

In regard to the third step of the operation, the implantation of a free fat transplant, I was not aware at the time of operating upon this case that this procedure had been employed in Dupuytren's contracture. But I have since read an article by Dr. Alfred Peiser in *Zentralblat f. Chir.*, Leipzic, 1917, xliv, 6–8, in which he advocates the use of a free fat transplant following the excision of the fascia through a flap incision whose base is toward the thumb. He states that a search of the litera-

ture shows that the free fat transplant had not yet been used in Dupuytren's contracture.

Spitzy employed free fat transplants in cases of contracture of the fingers and hand other than Dupuytren's contracture (*Zeitschr. f. orth. Chir.*, Stuttg., 1915, xxxv, 550–561).

While I have operated upon but one case, and it of recent standing, by the method above described, and am familiar with the objections which may be offered on this account, nevertheless, I am convinced that this procedure is in accord with sound surgical principles which have been frequently demonstrated in my own experience and in that of many others in plastic surgery of the hand and forearm.

GUNSHOT INJURY OF THE MUSCULOSPIRAL NERVE *

By Francis Reder, M.D.
of St. Louis

A musculospiral nerve injury with its sequelæ presents phases of unusual interest. The nature of the lesion, the time of its infliction and its location have an important bearing upon any prognostications that might be ventured.

The seriousness of a nerve injury can never be accurately judged from the symptoms observed. Nerve damage may be slight, yet the injured portion of the nerve may be lying in a mass of lacerated tissue and suffer seriously through the resulting cicatrization of these damaged structures. An apparently mild trauma of a nerve can engender changes in its internal architecture that may result in completely blocking its conductivity. A nerve injury exhibiting consequences which can be directly ascribed to it, has only one alternative, that of careful exploration and investigation. An exploratory measure promptly undertaken will not only clear up any suspicion of nerve damage, but it will, in case the nerve requires no surgical aid, be of material benefit in removing clotted blood and otherwise caring for the wounded nerve if it be in the immediate proximity of damaged bone.

Should the nerve injury require suture, then the exploratory measure will prove of definite value, inasmuch as primary suture of a damaged nerve gives a far better prognosis for anatomic and functional restoration than does late suture.

A few of the above facts are embodied in a gunshot injury of the left musculospiral nerve in a young woman who was attacked, the assailant facing her and standing at an oblique angle about 5 feet distant when he fired the shot. The ball, a 25-calibre missile, entered about 1½ inches above the anterior axillary angle and, ranging downward, found its exit at the posterior axillary angle. About eight hours later, when the patient was seen by me, she had fully recovered from the shock and the only condition that seemed to distress her was inability to use the left arm and hand. From the condition of the left hand, which was in a pronounced "wrist-drop" position, the inference could be readily made that the musculospiral nerve had been injured.

The paralysis of the triceps, the extensores carpi ulnaris and radialis, the extensor communis digitorum, all the extensor muscles of the thumb, together with loss of sensibility of definite areas in the back part of the arm, forearm and hand, gave evidence that the

* Presented before the Southern Surgical Association, December 17, 1918.

nerve was seriously injured; in fact, the diagnosis of complete division of the nerve was ventured. An immediate operative measure was suggested to the patient and was accepted. The location of the wound caused by the bullet made it speculative as to the best method of approach to the injured nerve. An oval flap joining the points of entry and exit with its concavity upon the inner part of the upper arm was decided upon. The flap was dissected down upon the chest wall and the axillary space fully exposed. The approach proved to be a very satisfactory one.

The removal of much clotted blood revealed the anatomic structures and by a careful dissection the relationship of vessels and nerves became readily demonstrable. After a thorough inspection of the musculospiral at the supposed site of injury, much to my surprise everything was found intact—not only did I fail to find a divided musculospiral nerve, but I could not even see where an injury to the nerve had taken place. It was an exasperating condition to be in, and I began to feel as though I might be lacking in definite anatomic acquaintance. In my desperation there came to memory an interesting dissertation on nerve injuries, known as concussion. The characteristic feature of such an injury is that the nerve is not touched, but is damaged by the vibrations caused by the passage of the bullet. These vibrations can be sufficiently severe to affect the nerve fibres and cause conductivity to be suspended, making it often impossible to clinically distinguish between severe concussion and nerve division. Strong as was my inclination to accept this version, I could not reconcile myself to apply it in this case, and the search for the lesion was continued. That my anatomical interpretation of the surgical field might have caused me to err, did not weigh heavily upon me, because I never lost faith in the size of the nerve held under suspicion—it was the largest nerve present. Furthermore, I felt certain of the location of the nerve as the structure was found behind the axillary artery upon the subscapularis, teres major, and latissimus dorsi muscles, and could be followed backward upon the long head of the triceps toward the musculospiral groove. Furthermore, the superior profunda artery was recognized in the immediate vicinity. This vessel was severed by the bullet. Manipulation of the structure dislodged the clot and the vessel started to bleed, making it easy of recognition. Fortified with these anatomical facts the identity of the musculospiral nerve seemed absolute. Imbued with the certainty that the nerve had suffered an injury, a most assiduous investigation was instituted. With the aid of a gentle irrigation of saline solution the field was cleared of all accumulated blood that vision might not be hindered. Viewing that portion of the nerve which lay in the track of the bullet, nothing unusual presented itself, the nerve appearing smooth and symmetrically rounded. Upon very close inspection, however, there could be seen upon the middle of the nerve sheath a reddish brown line about ½ inch in length, running parallel with the axis of the nerve. An endeavor to

brush away with gauze this reddish brown line was unsuccessful. It was then that the thought obsessed me that the bullet passed through the nerve, without inflicting gross damage to its investing sheath.

It became now an easy matter to demonstrate the injury. With two delicate forceps the neurilemma was caught in the immediate vicinity of the reddish brown line and by gentle traction in opposite directions the opening in the nerve was readily disclosed. The reddish brown deposit, which was coagulated blood clinging to the lacerated nerve sheath, was continuous with extravasated blood upon the internal structure of the nerve marking the path of the bullet. On the side of the nerve where the missile found its exit, a similar deposit of coagulated blood was seen clinging to the torn neurilemma.

Inspection of the wound in the nerve made it apparent why conductivity was lost. It now became a matter of speculation to what extent the axis cylinders and the minute internal architecture of the nerve had been destroyed. This was of much importance, inasmuch as the care of the wounded nerve depended upon some definite conclusion. Examination of the nerve trauma, after all extravasated blood in the path of the bullet had been removed by gentle scraping with a sharp knife and douching with saline solution, revealed nothing whereby the extent of the damage to the nerve structures could be judged. The clinical picture, depicting complete paralysis and loss of sensation, gave the only positive evidence of the seriousness of the injury.

In deciding upon a surgical measure for the wounded nerve, the guiding principle reposed in the proper approximation of the axis cylinders and the prevention of connective tissue intervention from the outside during the process of repair. The question of suturing the wound in a manner that would pucker the nerve was considered. It was, however, dismissed on account of the pressure the suture would exert upon the nerve tissue and the unavoidable tension which would be caused by the puckering, two conditions that must be avoided in nerve surgery.

The most feasible measure for this character of injury seemed to be the one which assured good apposition of all neurological structures in the track made by the passage of the bullet. It was reasoned that a gentle compression of the injured portion of the nerve, maintained for about two or three weeks, would give just as accurate an axonal contact and hold out just as encouraging an outlook for the regenerative potency of the nerve, as would any other surgical measure less free from traumatism.

In accepting this procedure the fact was borne in mind that a nerve which had been injured so that its axis cylinders are seriously damaged is prone to develop in it a type of connective tissue through which the axis cylinders do not subsequently pass and which leaves a permanent paralysis.

The application of this gentle compression measure entailed a

FIG. 1.—Showing incision of approach to musculospiral nerve.

simple technic, the only additional traumatism being the borrowing of a strip of muscle tissue from a convenient muscle—in this instance the strip was taken from the long head of the triceps, sufficiently large to be wound around the injured portion of the nerve with a generous encroachment upon its uninjured part. To make the compression effective, it was necessary that both ends of the muscle strip be secured. This was done by anchoring the ends with a catgut suture to muscle tissue in the immediate vicinity.

This procedure embodied two principles: that of compression sufficiently firm to make axonal contact certain, and that of prevention of connective tissue intervention from the outside. In all nerve injuries it is desirable to have a union free from the ordinary connective tissue type. All repair must be made by means of the proliferation of gial tissue in the large axones. It is the neuroglial type of connective tissue with its positive chemotactic attraction which favors the transmission of the axis cylinders and is of great value in nerve regeneration.

In choosing muscle tissue over other tissue, such as fat or fascia, a definite purpose was entertained. In muscle tissue there is an elasticity and a tone absent in fat. With fat only an unsatisfactory compression could have been accomplished, whereas with a fascial strip the purpose might have been accomplished with the risk of exercising too severe a prolonged compressing of the nerve on account of the density and inelasticity of the tissue. This would have most likely defeated the purpose for which it was intended. The strip of muscle tissue embodied all the requisites called for and the subsequent regeneration that took place with complete restoration of function and sensation gave full attestation to its value.

After closure of the skin wound and proper drainage of the axilla, the wrist-drop was held slightly over-corrected, with the arm and hand resting upon a comfortable splint. Fortunately for this patient the healing of the wound was not retarded by inflammation. For the first ten days there was a marked œdema of the fingers and hand, extending to about the middle of the forearm. The œdema subsided slowly and had fully disappeared when patient left the hospital three and one-half weeks later.

The following data were obtained as the patient presented herself for examination:

Two months after the injury, which happened December 30, 1917, 2.30 A.M., no sensory nor motor recovery was in evidence. The muscles of the hand and forearm appeared atrophic. On March 28th, twelve weeks after the injury, patient called and stated that two days ago she was able to move her fingers. Examination revealed that sensation (pin prick) in the anæsthetic regions had returned and that the patient was able to slightly move her wrist and her fingers at the metacarpophalangeal joints. On May 30, 1918, twenty weeks after the injury, a marked

improvement had taken place both in sensory and motor recovery. Although the wrist-drop was still pronounced, she was able to extend and flex her fingers to about 4/5 normal. On July 16, 1918, twenty-six weeks after the injury, the wrist-drop had greatly improved. There was, however, still a slight finger drop. Patient was able to grasp and hold objects with a sense of security. The muscles of the hand had taken on their normal appearance.

On October 28, 1918, forty weeks after the injury, the wrist-drop had entirely disappeared. The patient was able to extend and flex her fingers in a normal manner. Sensory and motor recovery had been fully restored with the exception that there still was a peculiar "dead" feeling in the ends of her fingers and that she was not yet able to pick up a pin.

THE APPLICATION OF EXTENSION TO OVERLAPPING FRACTURES, ESPECIALLY OF THE TIBIA, BY MEANS OF BONE SCREWS AND A TURNBUCKLE, WITHOUT OPEN OPERATION *

By Leonard Freeman, M.D.
of Denver, Colo.

The procedure herein described deals with the management of fractures of the tibia requiring forcible and prolonged extension which cannot be obtained satisfactorily by ordinary means.

The difficulties encountered in handling such fractures are well known, and the outcome is often unsatisfactory, as has been emphasized by Sir Arbuthnot Lane and others.

In most instances the bad results are due to overlapping of the fragments, leading to shortening, deformity and distortion of the weight-bearing axis of the limb. It is universally recognized that this generally can be overcome by sufficient extension properly applied; but to apply sufficient extension is not always easy by means of the devices usually employed.

The most common expedient is the use of a weight, cord and pulley; the cord being attached to the leg by means of adhesive strips, by a stocking glued to the skin, a shoe, or to a nail or wire passed transversely through the os calcis, according to the suggestion of Steinmann and Codivilla.

Difficulties present themselves in all these methods. For instance: When the break is low down there is insufficient room to apply adhesive strips or a stocking firmly enough to sustain the required weight. In addition, they are often out of the question in compound fractures or when there are abrasions, eczemas or blisters. A shoe is apt to be uncomfortable and impede the circulation of the foot, while the Steinmann procedure, although excellent in some respects, has certain drawbacks common to all the methods mentioned, in that it is cumbersome, takes up unnecessary room, puts great strain upon the joints of the ankle, knee and hip, and immobilizes these joints in a way that leads to stiffness and prolonged disability, to say nothing of the inhibition of the patient's movements.

In fact, the shortcomings of extension, as usually applied, are so real, and its results so unsatisfactory, that many surgeons have been led to adopt open operation as the method of choice. Without denying that this is sometimes preferable, it may, under unfavorable circumstances, lead to sepsis or delayed union. At best it is often a complicated undertaking requiring prolonged anæsthesia, much experience, and a faultless

* Read before the Oregon State Medical Society, June 26, 1919.

technic—occasionally appearing to the patient as more formidable than the condition would seem to indicate.

In order to overcome these difficulties I have recently devised a method of extension to which I desire to call attention.

Technic.—The instruments required (see illustrations) are: (1) Several *strong,* steel bone-screws, about 2½ to 3 inches in length and $^{3}/_{16}$ of an inch in diameter. (2) A drill making a hole slightly smaller than the screws (ordinary machine twist-drills are the most suitable). (3) A properly constructed turnbuckle. (4) A long clamp for holding the screws in position after adjusting the fracture.†

The operative steps are:

1. Obtain an X-ray picture of the break, noting the amount of overlapping of the fragments.

2. Prepare the skin as in any other operation.

3. Under general anæsthesia, adjust the fragments roughly, especially as regards rotation, being careful that the inner border of the foot is on a line with the inner border of the patella.

4. With a sharp-pointed knife make two small, button-hole incisions over the centre of the flat surface of the tibia, one on either side of the break and at some distance from it. They should be just large enough easily to admit the drill and should reach to the bone.

5. Insinuate the drill through the soft parts and bore clear through the medullary cavity, so that the instrument obtains a firm hold in the posterior osseous layer.

6. Remove the drill and replace it with a bone-screw, which gets a firm fixation because it is slightly larger than the drill, and penetrates both sides of the bone.

7. When the screws have been placed, one above and one below the fracture, insert the turnbuckle between them, close to the skin (Fig. 5), and apply extension, corresponding in degree to the over-riding of the fragments, previously noted by the X-ray, or by measurement of the opposite limb. When possible the progress of the adjustment may be observed through a fluoroscope.

8. Place the clamp upon the screws, as low down as practicable in order to reduce the leverage, thus maintaining the extension (Fig. 6), after which remove the turnbuckle. If either fragment tends to project forward beneath the skin it should be pressed into place before adjusting the clamp.

9. Apply dressings and a bandage. If only two screws have been used a light splint may be desirable to maintain the general alignment of the limb.

The after-treatment consists in changing the dressings every few days and painting the skin around the screw-holes with 2 per cent. tincture of iodine.

† These instruments can be obtained from W. H. Lauth, 1632 Court Place, Denver, Colorado.

FIG. 1.—Bone-drill in brace. Bone-screws and clock-key, the latter fitting the squared ends of the screws and also used to tighten the bone-clamp.

FIG. 2.—Side view of bone-clamp.

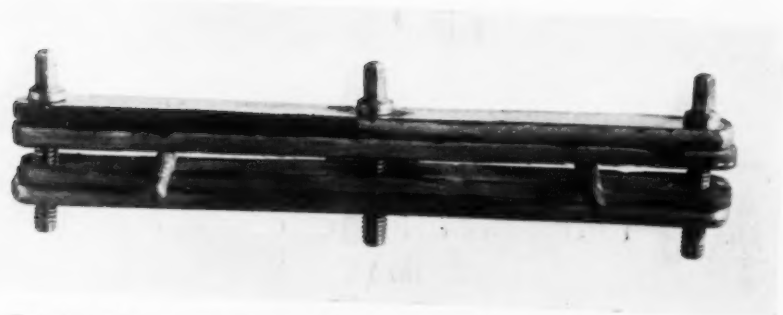

FIG. 3.—Top view of bone-clamp, showing lining of soft wood in which the bone-screws become firmly embedded when the clamp is tightened.

FIG. 4.—Turnbuckle.

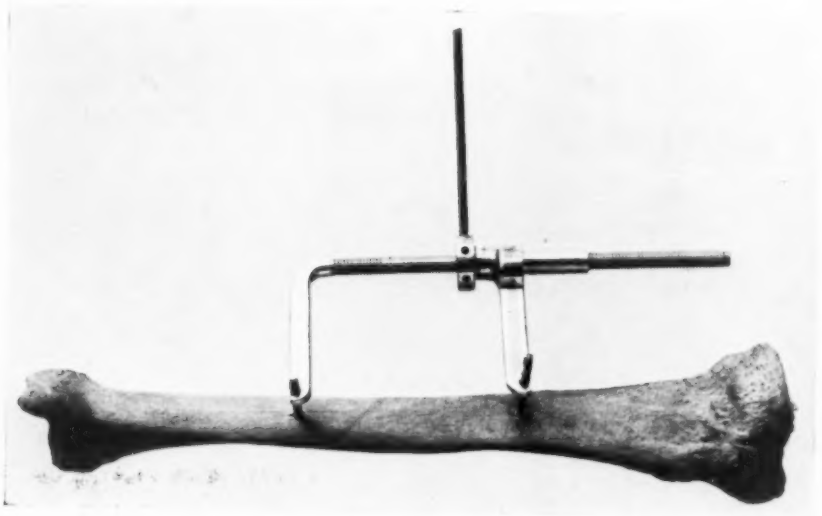

FIG. 5.—Turnbuckle in position for applying extension.

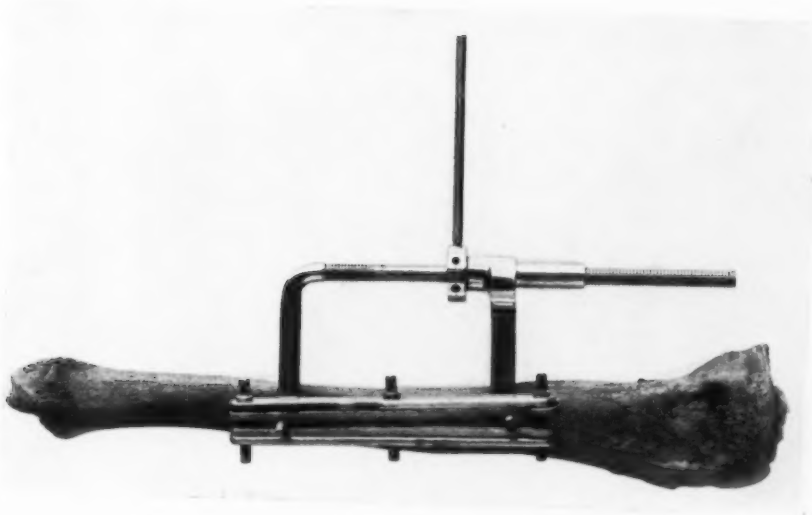

FIG. 6.—Bone-clamp in position before removal of turnbuckle.

FIG. 7.—Fracture of bones of leg with deformity (taken in splint).

FIG. 8.—Same as Fig. 7 after clamp extension (taken in wire splint).

If desired, the apparatus may be left in place for a number of weeks without hesitation, although in most cases sufficient union to permit of its removal in two or three weeks will have been obtained. Extensive experience during the late war with the Steinmann nail-extension and the caliper extension of Ransohoff has strongly emphasized the fact that nails, screws and calipers inserted into bones and left projecting through the skin may remain in position for a long time without infection, thus adding important testimony to the already abundant evidence gained with the external bone clamp.‡

When removal of the apparatus is decided upon, it is easily accomplished by taking off the clamp and unscrewing the screws from the bone. No anæsthetic is required, as but little pain is produced, or none at all. The holes are then painted over with tincture of iodine and usually close in a few days. A splint or a light case may be applied until consolidation is complete.

If one wishes, two screws can be inserted on each side of the fracture instead of one, thus gaining additional firmness, but this seems hardly necessary in the majority of instances.

By using a sufficiently long clamp one or both screws often can be placed far from the fracture, in sound tissues, thus avoiding disturbance of the injured parts—manifestly a desirable thing to do.

Attention should be called to the large amount of force at the disposal of the surgeon. In fact, it is limited only by the strength of the screws and the solidity with which they are embedded in the bone. A moderate amount of temporary, or even permanent, over-extension may be desirable, to aid in the replacement of fragments. This powerful extension, so easily, accurately and safely applied, enables one to overcome readily any amount of shortening, even after the lapse of a number of days, in spite of contraction of the soft parts, a feat which otherwise is hard to accomplish short of an open operation. I have done this as late as five or six days following the injury. At the same time that the shortening is overcome, the axis of the bone is brought into line and even displaced fragments may be replaced (Figs. 7 and 8). This action is due not only to the extension, but also to the side pressure of the soft parts produced by the tension under which they are placed.

The use of an external clamp causes very little discomfort—much less, in fact, than ordinary extension. This is because the fragments are held firmly, even during muscular spasm, while the soft parts and joints are free from the constant strain of a suspended weight. The surgeon's mind is also relieved of uncertainty regarding the amount of weight to be employed and the relative positions of the fragments.

In this connection it should be borne in mind that, however large the

‡ From an experience with 57 fractures of the femur, Bulkley and Sinclair conclude that "The ideal form of traction is skeletal, and this form of traction is practically without danger." ANNALS OF SURGERY, May, 1919, p. 492.

clamp may be, it lies entirely outside. The penetrating portions of the bone-screws represent a much smaller foreign body than does an internal bone-plate, and, unlike the latter, are situated at a distance from the seat of the injury. In fact, the comparative comfort of "clamp patients" is often a matter for comment.

It is, of course, apparent that the intervention of soft-parts, the twisting of the bones in spiral fractures, etc., may prevent reposition of the fragments and necessitate an open operation; but these things are exceptional and likewise apply to other methods of extension. Also, it is evident that the clamp will work better when the break is not too near the end of the bone; not only owing to lack of room for the screws, but likewise because the cancellous tissue gives them a less firm hold. Nevertheless, I have used it with satisfaction in such fractures.

To Dr. Clayton Parkhill,[1] of Denver, is due the credit of suggesting and popularizing the use of the external bone-clamp, in this country, at least. It was previously employed by Keetley, of London, and possibly others, but of this I am sure Doctor Parkhill was not aware. The Parkhill clamp, however, is so complicated that it is often discouragingly difficult to adjust, which is also true of other clamps, such as that of Lambotte. In addition, its construction is such that the screws cannot be placed at a distance from the fracture, and it is also impossible to use it for purposes of extension. My own clamp[2] (Figs. 2 and 3), consisting of two strips of metal lined with soft wood, is extremely simple and easy of application and permits of placing the bone-screws at any desired distance from each other and of varying this distance as required. Its efficiency has been demonstrated by its use for fifteen or twenty years, by myself and others. It is unnecessary to be provided with many clamps of varying lengths, one long one being sufficient for nearly all cases, even those in which the screws must be placed quite close together. Whether but two screws are employed or several (for the sake of greater firmness) is of no importance, providing they are placed in line with reasonable accuracy.

So far I have had no opportunity of applying the method of clamp-extension to any fracture except of the tibia, the initial operation being done on December 7, 1918; but I can see no reason why it should not be used upon other more or less superficial bones, such as the ulna and even the clavicle. (With the clavicle the drills and screws would have to be furnished with appropriate shoulders to prevent them from penetrating too deeply and injuring the underlying structures.) I have even wondered whether a broken femur could not be stretched in this manner by placing one screw just above the external condyle, as in the Steinmann nail-extension, and the other near the trochanter, where the bone is superficial.

To summarize the advantages of clamp-extension:

1. Facility of application and absence of cumbersome apparatus.

2. Effectiveness of the extension and exactness of its amount, as regulated by the X-ray or by measurements of the opposite limb.

3. Its applicability in the presence of open wounds and lesions of the skin, and its freedom from injury to the skin.

4. Absence of strain upon the articulations and soft parts and freedom of the patient to move both himself and his joints.

5. Comfort and safety from infection and avoidance of an open operation.

6. Placing of the screws at a distance from the break, thus avoiding disturbance of the injured tissues and the danger of increasing the likelihood of delayed or non-union.

7. Easy removal, without anæsthesia.

8. Admitting that the adjustment of the fragments sometimes may be less exact than with an open operation, nevertheless, the length and weight-bearing axis of the limb may be conserved by means of the extension-clamp, which, after all, is the main object in view.

It should be noted that Desguin,[3] in 1907, described a method of extension of oblique fractures of the tibia by means of complicated turnbuckles with their ends embedded in plaster casts applied about the limb above and below the fracture. Although the procedure is undoubtedly useful under certain circumstances, it is cumbersome, uncomfortable, apt to disturb the circulation, and cannot be used unless the skin is intact. The method has never become popular, perhaps for these reasons.

Since writing the above paper my attention has been called to an article by D. W. Crile,[4] in which he described a heavy and complicated apparatus for extension in fractures of the femur. Double-pointed calipers, applied to the femoral condyles, are used to control the lower fragments, while a large, square spike is driven into the trochanter. These are connected to a telescoping, socketed, steel bar by ball-and-socket joints.

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CANCER OF THE STOMACH AND ITS SURGICAL TREATMENT*

By Charles H. Mayo, M.D.
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Probably no word in medicine is more depressing to the patient than that of cancer in the diagnosis of his disease. We are assured by most clinicians that cancer is on the increase; possibly this increase is more apparent than real and is due to the greater general diagnostic ability of the medical profession and the better facilities for obtaining statistics. A general knowledge, as well as fear, of the disease is gradually spreading, largely the result of the propaganda of the publicity committee of the American Medical Association, and the work of the special cancer commissions, all of which is creating a favorable evolution of opinion, and causing more persons to seek treatment during the earlier stages of the disease.

The most common cancer is that of the stomach. More than one-third of the cancers in men and more than one-fifth of the cancers in women appear in this organ, and inasmuch as the condition in nearly one-half of such patients who come to the physician for examination is inoperable, there is room for some improvement in the matter of securing earlier recognition of the disease. At best, however, the gain will be comparatively small over present conditions, because in many instances the disease gives but few symptoms until it is far advanced, and because approximately 75 per cent. of cancers of the stomach are so located or of such a type that early metastasis takes place into glands and into other organs, or it may become grafted throughout the peritoneum; to prevent this early operation is essential. About one-fourth of gastric cancers are confined to the stomach, and in this group if glands are involved they are in or connected with its wall without papillary outgrowth. These are the most favorable cases for operation, and yet all of this type are not operable for various reasons, advanced age, general debility, complicating diseases, or extensive involvement of the stomach. In the inoperable group may be placed the cases involving the cardia, approximating 10 per cent. of the gastric cancers.

The literature concerning the general subject of cancer, especially of its etiology, is voluminous. Usually such articles are written with the object of proving special theories: for example, that cancer is or is not an hereditary disease, that it is caused by some unknown infection, or that this infection is water-borne, that it is due to malnutrition, general and local, and hence is a medical disease; that it is due to acids, especially of the sulphurous type, or to the excess of cholesterol.

* Presented before the American Surgical Association, June, 1919.

Cohnheim's theory of tissue displacement as a cause has long since been refuted. In taking a general survey of the various theories and reviewing the clinical evidence, it would seem that not one, but several conditions are essential to the development of cancer. The influence of heredity probably does not extend beyond an inherited cell weakness in which extra demand on the cell for division may early exhaust its controlling agent. The great influence of local irritation, which in some instances is undoubtedly chronic infection, is a fact quite generally accepted. No one theory, however, can account for the change in the cell that causes it to adopt lawless existence and to lose its harmony with community life. There is little change from the normal in the cancer cell, yet by the microscopic study of a group of cells and their relationship to surrounding tissues, cancer can be identified positively. An acid condition in the surrounding fluid also seems essential to cancer activity. Hot drinks are probably a cause of no little importance in producing cancer of the stomach.[1] Chronic ulcer is the most important factor to be considered in these cases, as in well over 40 per cent. there is a history of ulcer varying from many months to several years before the onset of cancer. When seen early such cancers are found to have developed on the margin of an ulcer. In such location the demand of cell renewal is constant; when some cell exhausts its controlling granules in the division, and reverting to single cell type, becomes parasitic, we may have the beginning of cancer, but only if other factors are present. The type and growth is dependent on the basal cell and the environment. In a general way it may be said that the nucleus is proportionately larger in the cancer cells, and is ready for division with less than the average amount of cytoplasm surrounding it. Individual cells, as well as groups, must be studied. The various parts of the cell, taking different colors through the varying action of stains, show the complex chemical structure of the protoplasm. It is within reason to assume concerning the normal division of a cell that its control is the centrosome; possibly other granules may serve this purpose. Cell growth in cancer is undoubtedly stimulated by acidity or greatly lowered alkalinity. In this connection it is of interest to mention the work of Loeb. He found by a brief immersion of the unfertilized eggs of sea urchins in a 1 per cent. solution of butyric acid and sea water, that the eggs became fertilized and took on active growth, without sperm. On the other hand, it has been shown that eggs of certain types of lower animals that develop in water, when placed in 0.6 per cent. saline solution develop with frequent anomalies, especially of the higher nervous system, the last addition in evolutionary life.

The greatest number of cancers come in the area of highest acidity, the stomach. Ninety-eight per cent. of intestinal cancers are in the colon, while cancer in the small intestine is relatively rare—about 2 per cent. Cancer in the urinary bladder is not uncommon, while in those organs

[1] Mayo, W. J.: Cancer of the Stomach. Surg., Gynec., and Obst., 1918, xxvi, 367–370.

with a limited period of activity, such as the breast, uterus, and prostate, a normal degeneration often becomes a pathologic one, the stimulating influence probably being of a chemical nature. Cancer of the duodenum is exceedingly rare, yet ulcer of the first portion of the duodenum is nearly four times as frequent as ulcer of the stomach, and while there is opportunity for involvement by continuity of tissue from the most frequent site of cancer in the body, the stomach, this does not occur. Ulcers appear in the first portion of the duodenum as it is bathed by the acids of the stomach before they are neutralized by the secretion of Brunner's glands; ulcers do not appear in the alkaline portion of the intestine below the common duct, although they may be found in a gastrojejunal opening which has there been rendered acid.

While I am not presenting this subject from the standpoint of diagnosis, I wish to refer to the progress which has been made in the diagnosis of gastric cancer, and to corroborate Carman's observations on the operability of cancer of the stomach as determined by the X-ray. Without the X-ray we would be back to the old methods of determining diagnosis, namely, by cachexia, loss of weight, achlorhydria, obstruction, tumors, etc., which are all signs of advanced gastric cancer. At a time when the cancer syndrome is not positive but probable, the X-ray may be relied on to demonstrate lesions of the stomach in more than 95 per cent. of the cases.

In general the treatment of cancer by radium is proving successful in certain types of the disease which can be reached by the ray; in some instances cure is produced and in others growth is delayed. By care and filtering processes the various rays are controlled. The effect on the cell is chemical, influencing the protoplasm or the local fluids. Radium is most effective in growths with active circulation, as it has a marked influence on the wall of the blood-vessel. It also apparently acts on the cell nucleus, checking division, but it may be used to excess and cause local destruction. The X-ray acts on the cell protoplasm, checking growth, and it may also cause local destruction. Between these two conditions, the X-ray causes rapid epithelial proliferation, areas of which might at times be called pre-cancerous. The cell having lost its controlling granules through the ray's action and retaining its nucleus and cytoplasm will become malignant when surrounded by the proper biochemic fluids. This shows that under certain conditions cancer can not only be produced but controlled. As yet radium and X-ray are only palliative or a means of delaying the progress of gastric cancer.

From October 1, 1897, to January 1, 1919, we performed 2094 operations for cancer of the stomach. Seven hundred and thirty-six of these were resections with a mortality of 13.7 per cent., 746 were explorations with a mortality of 2.9 per cent., and 612 were palliative operations with a mortality of 11.1 per cent. The common type of operation was the Mikulicz, Hartmann, Billroth No. 2, of which there were 359, with a mortality of 12.5 per cent.

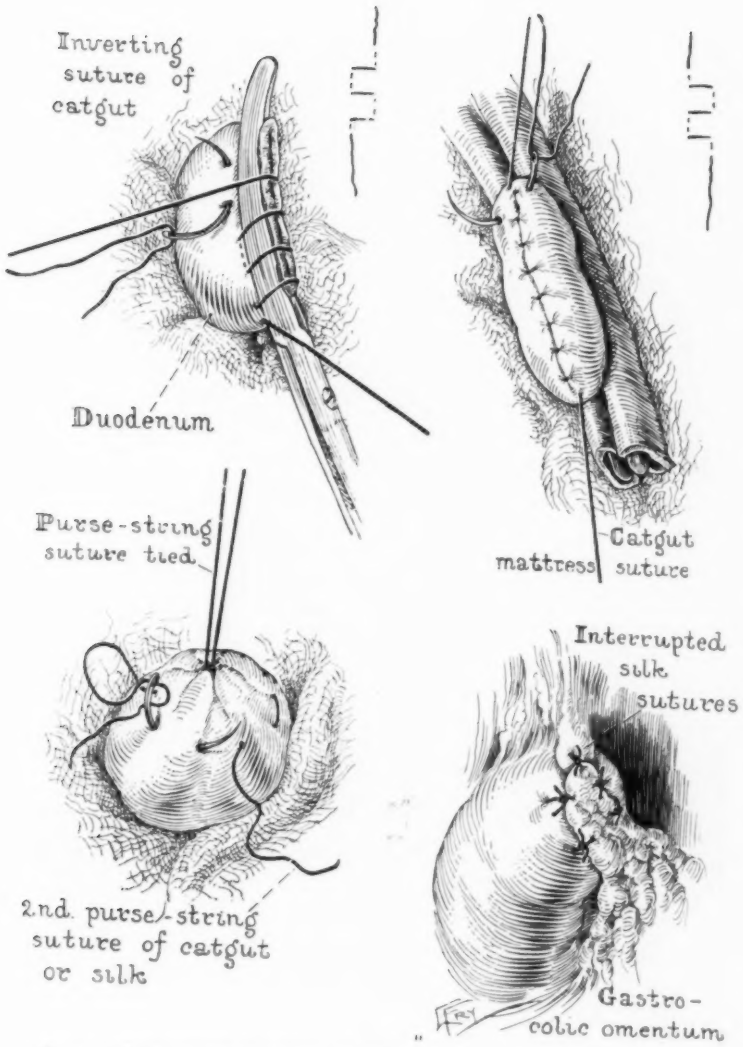

FIG. 1.—Two methods of closing and protecting the cut end of the duodenum.

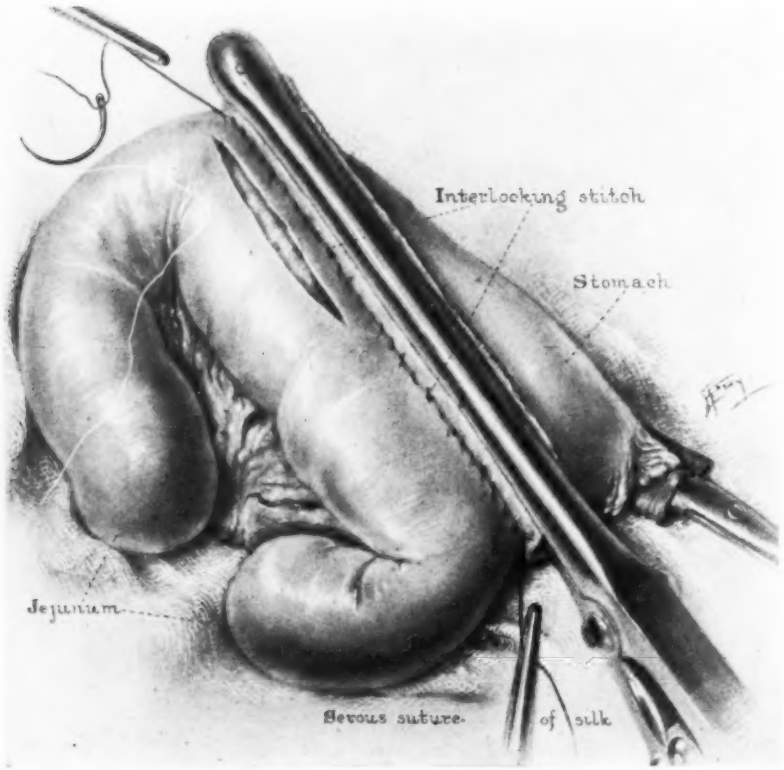

FIG. 2.—Jejunal attachment; approximate size of opening in bowel.

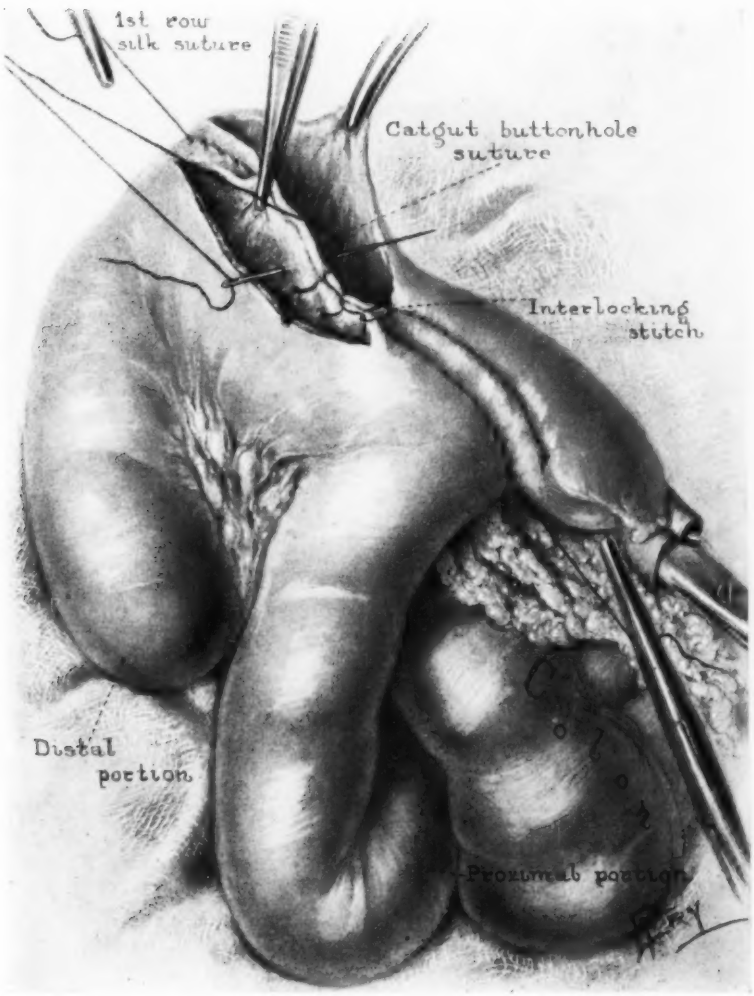

FIG. 3.—Gastro-enterostomy opening with partially closed end of the stomach.

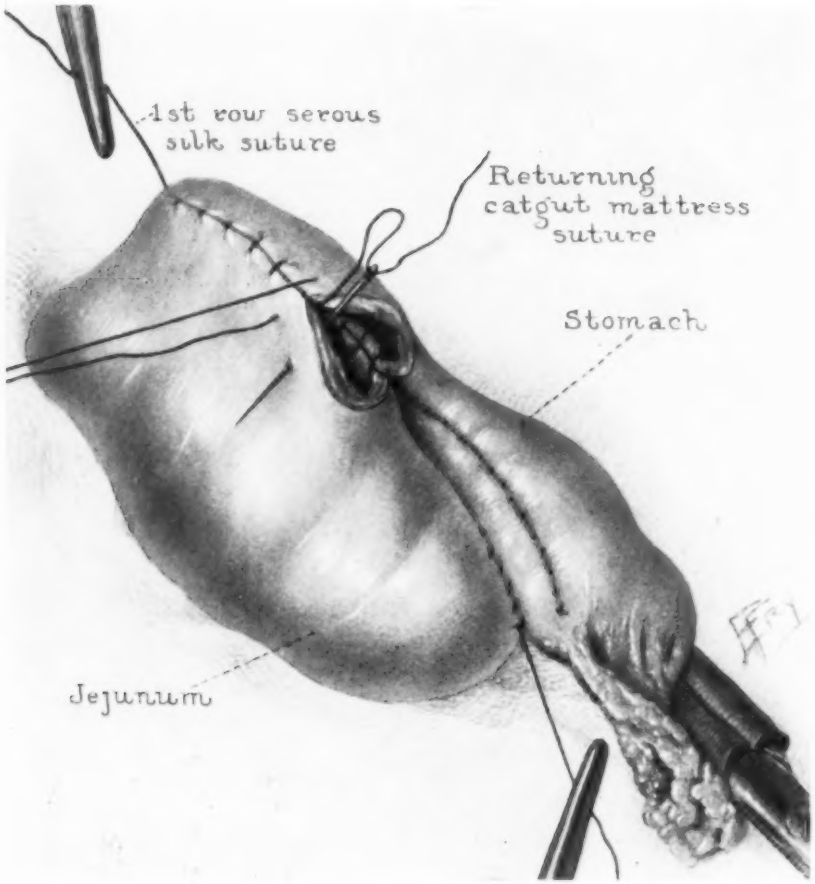

FIG. 4.—Catgut suture closing gastrojejunal opening and continuing over the closed portion of the stomach to reinforce the suture line.

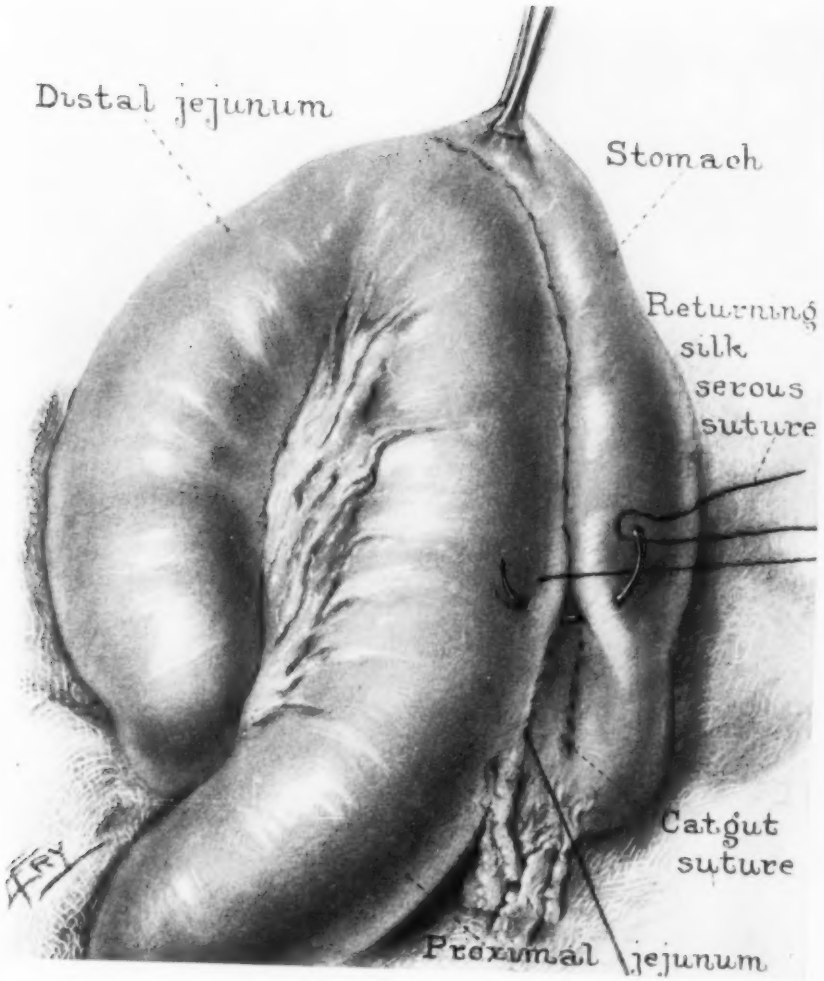

FIG. 5.—Final row—serous suture completing suture line which protects the end of the stomach with the intestine.

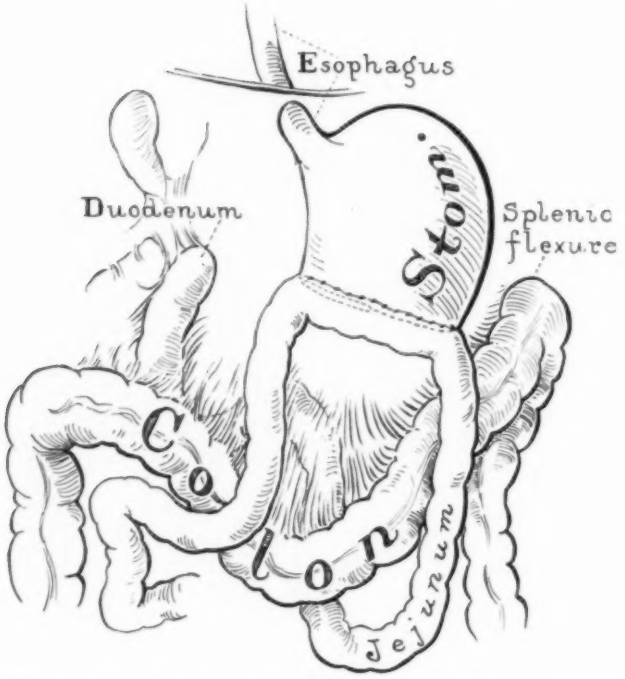

FIG. 6.—Schematic diagram. Method of attaching jejunum and stomach. Omentum not shown.

There were 19 of the Billroth No. 1 type with a 5 per cent. mortality, 28 sleeve resections and 7 Kocher operations with a mortality of 14.2 per cent. each, 115 posterior Polya operations with a mortality of 14.7 per cent., and 120 anterior Polyas with a mortality of 13.3 per cent. The local resections, 12 in number, gave the highest mortality, 25 per cent. These 660 resections have been done since 1906. Prior to this the type of resection was not described in the records definitely enough to be included in a statistical report. The Billroth No. 1 operation consists of a resection of the pyloric end of the stomach, and the suturing of the duodenum to the partially closed distal end of the remaining portion of the stomach. Since the Y-shaped line of suture of this type of operation frequently leaked with fatal results, Billroth, with Mikulicz and Hartmann, developed the so-called Billroth No. 2 operation, which consisted of completely closing the end of the stomach and making a posterior gastrojejunostomy. The Kocher operation avoids the leakage of the Billroth No. 1 operation by attaching the end of the duodenum through an opening in the posterior wall of the stomach after the open end is closed, but tension here occasionally gave obstructive trouble or leakage (Figs. 1 and 2). Polya avoided the double operation of closure of the end of the stomach followed by gastro-enterostomy, by uniting, retrocolic, the whole open end of the stomach to an equal sized opening made in the jejunum. In the Polya operation the newly formed end of the stomach consists of the jejunum, which spreads out as the stomach is filled; the opening may be from three to five inches in length, according to the size of the resected end of the stomach. If the opening is but three inches, the whole end of the stomach may be attached to the jejunum by incising the bowel a nearly equal distance; with each passing of the needle, the suturing loops catch a somewhat greater amount of the wall of the stomach than of the bowel. Since the bowel becomes the stretched-out end of the stomach with an opening at each side of the attachment, proximal and distal, the delivery of gastric contents is not so well accomplished as it is with the partially closed end of the stomach with an ordinary sized gastro-enterostomy opening properly placed (Fig. 3). The mortality rate incident to the various operative methods is nearly the same; there is, however, some difference in the comfort and postoperative condition of the patient. In the operation described herewith this large opening is avoided by attaching the jejunum to the posterior wall of the stomach close to the crushing clamps, which are left on to hold the stomach closed until the first row of sutures is applied. Before removing the crushing forceps the contents of the stomach are controlled by applying long, flexible rubber-covered forceps, slightly higher on the stomach, which prevent its contents from soiling the wound. After the first row of sutures has been made and the crushing forceps removed, the stomach is partially closed by an inturning suture, begun at the greater curvature, closing in toward the lesser curvature until the opening remaining is only slightly greater

than the diameter of the jejunum. The jejunum is now opened opposite this point, a quarter of an inch from the first suture line, and the ordinary technic of gastro-enterostomy is completed. The opening being closed, the suture is continued as a second row over the closed portion of the end of the stomach. The first suture is now continued over the anterior portion, making two rows on the gastro-enterostomy opening, and protecting still further the closed end of the stomach by suturing over it the unopened bowel (Fig. 4).

For the last three years we have been doing the anterior Pólya, the original Kroenlein instead of the posterior, bringing the loop of jejunum over the transverse colon. We abandoned the posterior Polya because of primary obstructive complications due to adhesions, to tension from gastric traction, or to late trouble from recurrence of the malignancy, with early obstruction. The anterior operation gives an easier convalescence on the average (Fig. 5). I believe that better after-results are secured by turning the bowel to the right, isoperistaltic, which was a marked feature in the earlier operations of anterior gastro-enterostomy. The point of attachment of the jejunum is approximately fourteen inches from its origin, while the opening in the stomach comes directly over the descending leg of its loop, the reverse of the Mikulicz partial closure and button anastomosis. The transverse colon naturally sags in its mid portion; by turning the bowel from left to right it is brought to the left of the centre, while the stomach delivers along its lesser curvature, the more fixed portion of the viscus. Inasmuch as the tissues of the stomach are more or less devitalized by disease and more so by the operation, the suture material recommended is silk for the outer row and chromic catgut for the inner row; the silk guards against separation from delayed healing (Fig. 6). The completed operation can be made within one hour.

Our data bring the results of operation up to September 1, 1917; four hundred and twenty-seven patients were operated on during the three years previous to September, 1917. Those who died in the hospital, and those not heard from, number 121. Those who recovered from the operation and who have been heard from number 306; 115 (37.6 per cent.) of these show three-year cures. Three hundred thirteen patients were operated on during more than five years before September 1, 1917. Those who died in the hospital, and those not heard from, number 79. Those who recovered from the operation and who have been heard from number 234; 59 (25 per cent.) of these show five-year cures. This is a most satisfactory showing for the surgical relief of an otherwise hopeless condition which is attended by much suffering.

THE METHOD OF RECORDING SURGICAL OPERATIONS AT THE FRONT*

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of Philadelphia

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"They do these things better in France," is a phrase which had passed into history many years before the great German War, but the truth of which has been verified anew in many respects during the experiences of the last four years. Especially, from the military point of view, did I find this to be the case with the methods of recording surgical operations during the hurry of work in advanced posts. Surgical Team No. 23, U. S. Army, of which I was the senior member, with Lieut. Henry S. Kerchner as my Assistant, together with two nurses, an anæsthetist, and two enlisted men as operating room assistants, worked for three months in a French "Autochir," and it became our duty to put on record in French an account of each operation as it was done. So explicit is the French language, and so nicely does it lend itself to terse and accurate expression, that when later our activities were transferred to an Evacuation Hospital of the United States Army, we carried along with us certain habits of expression which might well be officially adopted into the military code of armies other than the French.

In order for any statements, spoken or written, to be clear and intelligible, it is first and foremost necessary for the speaker or writer to know definitely in his own mind the points he wishes to have recorded and the order of their statement, and for him to employ definite and fixed terms of expression. These habits the French surgeons have acquired, and they gladly pointed out to us the important facts which should be recorded, as well as the value and significance of certain habitual abbreviations.

The patients would arrive at the operating room of the autochir with their "pochette" (the diagnosis envelope) already made out. This had been done at the "Triage" (sorting centre) of the autochir, the patient's name, rank, etc., and the "diagnostic sommaire" (summary diagnosis) being recorded on the outside of the envelope (Fig. 1). Here also was recorded the *date and hour of injury,* whether or not the *injection of antitetanic serum* had been given; and when the patient was dismissed from the operating room or later when discharged from the ward, other notable facts were added on the outside of the envelope, such as the *nature and date of any important operation;* how the patient was to be *transported* (sitting or recumbent); whether he was to be transported only a short distance, or to the intermediate zone,

* Read before the Philadelphia Academy of Surgery, May 5, 1919.

or to the interior; whether he was an officer, a member of one of the allied armies, a Musselman (important because no wine could be taken by such patients), etc.; as well as *treatment required during transport* (diet, *i.e.*, regular, special, or liquid); whether or not *catheretization* was required; the *date of the last dressing* of the wound, and the date when it should be dressed next; and finally the special service to which the patient was to be assigned on arrival at the rear. Most of these facts could be indicated by underscoring or striking out with a colored pencil.

Inside the pochette, on arrival at the operating room, was a slip of paper on which the radiologist had recorded the results of his fluoroscopic examinations. These radioscopic diagnoses were models of accuracy and neatness, considering the great speed with which the examinations had to be made.

For the space of one minute or thereabouts, intervening between the time the surgeon could turn his attention from the last patient to the patient next in order, opportunity was afforded to scan the summary diagnosis on the outside of the envelope, and to read the radiologist's diagnosis. Toward the conclusion of each operation the surgeon would then dictate in French (or, if an American surgeon, then in patois), what was to be recorded for the information of the surgeon into whose care the patient should come at his next station. This dictation, taken down by a clerk (or in emergency written by the surgeon himself, or by any of his staff who understood French), was written on another scrap of paper (paper was valuable and scarce); this also was placed in the *pochette,* and accompanied the patient to his permanent hospital, where " fair copies " could be made of all the scraps of paper which had accumulated on the journey. When time permitted, this fair copy was made in the office of the autochir, in manuscript, on the " Billet d'Hôpital à Coupons " (a folded form on which the Field Medical Card of the United States Army is modelled), and this also was placed in the *pochette,* and was signed by the " Médecin Traitant " or Ward Surgeon.

The French surgeons made a habit of keeping for their private records a copy of their dictation, and needless to say this habit also was gladly adopted by the American teams working with the French. A small notebook, carried in the pocket, furnished all the scraps of paper required; alternate pages were written on, and the intervening carbon copies were torn out and placed in the *pochette.* It is true that the Médecin-Chef had occasion once to complain that the carbon copies placed in the pochette were " presque illegibles," but it is believed this applied to copies furnished by one of the French teams, at a time when the supply of carbon paper had been nearly exhausted.

The points to be recorded on these scraps of paper were the following, and in the following order, as near as might be: The formation where the operation was done, the patient's name, rank, etc., the date and hour of injury, the date and hour of operation, the summary diagnosis, including the nature of the missile; the X-ray report (this was always repeated in condensed form under the description of the operation, in addition to the

original report furnished by the radiologist); a concise account of the operation and the condition of the wounded parts; the dressing of the wound; whether the patient was to be evacuated at once or to be held for further observation; and the means of his evacuation (*i.e.*, by hospital train, by motor ambulance to the nearest hospital centre; or, if a trivial injury, to the centre near the front where such patients were sent for recuperation before immediate return to the lines); and, at the end, the operator's name.

The autochir with which we were longest associated (Ambulance Chirurgicale Automobile No. 6, of which the Médecin-Chef was M. le Professeur Agrégé J. Guyot, of the University of Bordeaux) was situated in the outskirts of a village called Crève-Coeur-le-Grand, in Picardy, in back of Montdidier (and Cantigny), south of Amiens, and about 20 kilometres north of Beauvais, the nearest large town, which before the war had a population of about 20,000. The slightly wounded ("minima") were evacuated usually to Songeons, a town toward the west, in the intermediate zone ("Zone des Étapes"); but if the railroad happened to be cut by the German bombing expeditions, they were sent to Grandvilliers, nearer at hand; the severely wounded, including almost all the fractures, were sent by ambulance to Beauvais, which was a large hospital centre, and a flourishing one until the German bombing expeditions made life there, even in hospitals, rather precarious; while those patients who could travel to the interior of France were taken by ambulance to the H. O. E.[1] (Evacuation Hospital) about a kilo and a half distant on the Froissy road, and were there loaded on the Train Sanitaire.

Appended are a few typical records in Americanized French, from our service at Autochir 6, and some corresponding records, in Gallicized English from our service at Evacuation Hospital 6, U. S. A. (Souilly, south of Verdun). Explanations of the abbreviations are given in tabular form, for convenience of reference.

The United States Army did well to copy their Field Envelope and their Field Medical Card from the French; but in one essential point the American surgeons were inferior to the French in training: they did not know, and they had not been taught the important points which should be recorded. And the Field Medical Card was faulty in that it did not contain any place for recording the *hour of injury*. Space was provided for recording the hour *first aid* was given, but it is of no use to know the time of this unless it is known how long a period elapsed between injury and first aid. Moreover, experience has shown that "first aid" was very much less important as a factor in preventing infection of the wound than the first operation—excision, debridement, and extraction; and in the future it is the hour of injury, rather

[1] The formula H. O. E. is derived from the term Hôpital d' Evacuation, which in the early days of the war was abbreviated as Ho. E., and by the corruption of sign painters subsequently degenerated into H. O. E. At least this is the explanation given by the French themselves.

than that of first aid, which should be carefully recorded. The patient almost always knows approximately the hour of his injury, even though he may not know the day of the week or month, and these latter can be supplied by the surgeon. The American Field Medical Card is also troublesome because too long to fit snugly in the Field Envelope; and, being made of cardboard, it is impossible for the surgeon to take a carbon copy from it, if he makes his record directly upon it, as was evidently the intention, and as was the practice as long as the supply of Field Medical Cards lasted.

The habit of the American army in recording all war wounds as "gunshot wounds" (G. S. W.), is another stumbling block to an accurate and terse statement of facts, unless it be considered of extreme importance (which it is not) to distinguish between these and the almost unknown bayonet or sabre wounds. The important point for record is the *nature of the missile*, and especially whether it was a shell fragment or a ball; the difference between a wound by a rifle ball and a machine gun bullet is negligible, except for medico-legal investigations, but the difference between a wound by a shell fragment and any kind of a bullet may mean the difference between gas gangrene and rapid healing, and this fact (nature of the missile) should always be recorded. Likewise the difference between wounds by shell fragments, grenade fragments, and fragments from aeroplane bombs, is negligible, except in a sentimental or historical sense. The habit of marking all these wounds merely as g. s. w. makes the surgeon in too many cases feel he is absolved from any further record. It is more satisfactory in every way, for the clinical history of the case, if the injury is recorded as "wound by ball" or "wound by shell fragment." It is worth while to note that wounds by "shrapnel" are quite rare, and that the term is carelessly and erroneously used as equivalent to shell fragment. It is also important to distinguish in the record between penetrating and perforating wounds: in the former the missile has lodged, in the latter it has passed all the way through. After this initial formula "Wound by shell fragment penetrating right thigh" or "Wound by ball perforating left forearm," should appear, in the summary diagnosis, the main complication, as "with fracture of femur, middle third," or "with section of ulnar nerve and artery above wrist."

Next should come a statement of the positions of the wounds of entrance and of exit, if the latter exist. If either wound is abnormally large and ragged it should be so stated. A concise and abbreviated description of the operation follows: In most cases it is sufficient to state "excision, débridement, extraction," as these terms denote definite and well-recognized procedures. If the foreign body is not found, this fact should be noted; or if it was so small as to be negligible and was not searched for, it should be so stated. If counterincision is made to facilitate extraction of the missile, or for the purposes of drainage, the fact should be noted. If arteries have been sectioned, the fact that they have been ligated should be a part of the history; or if a nerve has been injured its condition (contused, or sectioned)

and the treatment adopted should be indicated. In cases of fracture the treatment of the fragments should be recorded, especially whether or not fragments have been removed, and the extent of the esquillectomy (large, medium, or parcimonious). The antiseptic employed also should be noted. It is sufficient to record it very summarily—as iodin, Dakin, Mencière. The method of drainage (tube or wick), the dressings and splints should form a part of the record.

Now to get all these facts in the record requires not only systematic dictation, but it requires a clerk with a reasonable knowledge of surgical terms, a good general education, and above all a good handwriting, and speed and accuracy. It is important to get through with as many operations hourly as is humanly possible. To demand this clerical work of the anæsthetist or of one of the surgical team needlessly delays the commencement of the next operation. The French reckoned that the utmost speed conceivable would not permit the surgeons to average more than four patients in an hour, and they were quite well satisfied when a speed of three hourly was maintained. This requires not only that the patients be supplied to the operating room at that speed (which demands machine-like working of the triage, the preparation rooms, the sterilizing plant, and the fluoroscopic examinations), but it requires also that the patients leave the operating room at the same speed. While we were with the French it was possible at most times to maintain this average (three patients an hour, or about 24 patients in the eight-hour period of operating), with the aid of the clerks they supplied and the wonderful coördination maintained in the accessory services mentioned above. But with the American army we never could average more than two patients hourly except for very short periods at a time.

I would recommend, therefore, that before the next war the following modifications of the methods now in use of recording surgical operations at the front be adopted:

1. A field card of thin, tough, non-bibulous paper, of a size to fit easily inside the field envelope.

2. A space on the field card for recording the time of injury.

3. The records to be made in indelible pencil, and the surgeon encouraged to keep for his personal use a carbon copy of the records.

4. The abolition of the cumbersome term "gunshot wound" and the substitution for it of the term "wound by shell fragment (or ball, or grenade fragment, or shrapnel, or airplane bomb, etc.)."

5. The adoption of the French terms "Orifice of Entry" and "Orifice of Sortie," abbreviated as O. E. and O. S., as more terse than "Wound of Entrance" and "Wound of Exit" which cannot be so intelligibly abbreviated.

6. The provision of trained clerks for recording the surgeon's dictation. These clerks could be trained under the auspices of the Red Cross and would prove a valuable addition to the surgical teams for work in the advanced area.

EXAMPLES OF OPERATIONS RECORDED IN FRENCH

A.C.A.6.
Peruy, Charles, Cpl. 49 Inf., Cie. 3
Bl. 8. 6. 18, 12 h.
Op. 8. 6. 18, 1/2 h.
Plaies multiples par E. O.
Radiog.: Bras g.: petit éclat superf., face ext.
Main g.: plusieurs tres petites éclats.
Cuisse g.: éclat face int. du femur niveau trochanter minor.
Region lombaire et pied g., neg.

1. Excis. et débrid. d'un plaie region lombaire g., hematome; projectile non trouvé; excision d'un bouillie des muscles lombaires. Mèches iode.

2. Débrid. O. E. niveau troch. major face post. Fracture découpée de la troch. minor. Extraction d'un projectile tranchant. Drain et mèches iode.

3. Débr. O.E. et S. region malleolaire post. g. Trajet a passé en avant du tendon d'Achille et il y a section de l'artere et veins tib. post. Ligatures. Nerf intact. Mèches de part en part, iode.

4. Débr. et extr. d'un projectile de la muscle triceps au dessus du condyle ext. de l'humerus g. Mèch iode.

5. Nettoyage de la main.

A Garder.

A. C. A. 6.
Hoffman, Carl, Soldat, 1e. Eng., U. S. Army.
Bl. 28. 4. 18, 12 h.
Op. 29. 4. 18, 17 h.
Plaie penetrante epaule gauche par E. O. O. E. 2.5 cm. en avant de l'acromion.
Radio: Petit projectile (grosse tête d'epingle) repère à 3 cm. de profondeur (bras le long du corps). Ce projectile se profile entre l'acromion et la tête humerale, au contact de la tête, probablement intra-articulaire.
Incision, extraction du projectile sous l'ecran, logé dans la capsule au dehors du tendon bicipitale. Suture des muscles et de la peau.
Evacuer, T. S. Crèvecoeur.

A. C. A. 6.
Naouar, Oub Abder Kader, 2e. Cl., 7e Tir.
Bl. 26. 4. 18
Op. 27. 4. 18, 22 h.
Plaie perforante cuisse gauche par balle, entré en avant, sortie posterieure en dehors du femur.
Débridement, excision large. Drain de part en part. Mencière.
Plaie en seton region lombaire gauche.
Débr., excis., Mencière.
A Garder.

A. C. A. 6.
Hains, Theodor, 34e. Inf. Allemand.
Bl. 9. 6. 18, à nuit
Op. 13. 6. 18, 14 1/2 h.
Plaies penetrantes, crâne, épaule et bras g., par E. O. Les plaies de la tête et du creux axillaire g. sont infestées par des vers.

1. Plaie pen, pli post. de l'aiselle g. Exc., débr., extr., du projectile par contreouverture au pli anterieur de d'aiselle. Drain de part en part.

2. Seton du bras g. Excis. Mèche de part en part.

3. Grande plaie du cuir chevalu, region parietale gauche. Excision, extraction du projectile fixé dans le crâne. Autoplastie du cuir chevalu.

4. Éclatement oeil g. Enucleation et esq., fracture orbitale.

5. Plusieurs plaies superficielles de la face g., excision et sutures.

A Garder.

EXAMPLES OF OPERATIONS RECORDED IN ENGLISH

E. H. 6.

Switzer, Joseph, 61st Inf., Co. C.

Wd. 10. 12. 18, 6 h.

Op. 10. 12. 18, 19 h.

Wd. by ball entering outer face l. thigh, leaving inner face l. thigh, middle 1/3, traversing penis with rupture of corpus cavernosum and laceration of foreskin, then causing tangential wd. r. thigh.

X-ray neg.

Op. ether. Nett. of wds. Suture of penis. Iodin.

Evacuate.

E. H. 6.

Ricotte, Antonio, 61st Inf., Co. F.

Wd. 10. 16. 18, 18 h.

Op. 10. 17. 18, 17¼ h.

Wd. by S. F. perforating face and skull, with F. C. C. rt. mastoid region. Patient has been in shock ward since admission. Has cerebral symptoms, some rigidity of neck. Rt. eye marked exophthalmos. Punctured wd. to left of root nose. Brain oozing from external auditory meatus. Missile probably entered at nose and made its exit through mastoid. X-ray neg.

Op. Ether. Excision of scalp wd., of prolapsed brain, and of all depressed and soiled fragments of bone. Complete closure of scalp by autoplasty. Iodin.

Hold.

E. H. 6.

Carden, Stanley, 316th Inf., Co. C.

Wd. 10. 11. 18, 13 h.

Op. 10. 13. 18, 2h.

Wd. by S. F. penetrating rt. buttock.

X-ray, buttock: F. B. 20x15 mm., 70 mm. deep.

Op., ether. Debr. and extr. from beneath sciatic nerve. Persistent bleeding from branch of gluteal artery controlled with great difficulty by suture and ligature. Tube. Iodin.

Evacuate.

E. H. 6.

Clavridge, Gilford, 39th Inf., Co. K.

Wd. 10. 10. 18, 6 h.

Op. 10. 10. 18, 21 h.

1. Wd. by S. F. perforating rt. leg, with fracture of tibia and fibula.

2. Wd. by S. F. penetrating calf rt. leg.

3. Wd. by S. F. tangential, left calf, lower 1/3.

X-ray: fracture of leg, F. B. 10x15 mm., 40 mm. deep.

Op., ether: 1) O. E. ant. face middle 1/3. O. S. through Tendo Achillis. Debr., Esq. parc. 2) Extr. of S. F. from wd. of calf. Cabot splint by Lt. Moore. 3) Nettoyage.

Nom | Prènoms | Grade | Corps, Compagnie, etc.

Diagnostic sommaire

Ci-dessous, souligner au crayon de couleur les mentions utiles

Blessé le.....

Injections antitétan. — 1re: faite le..... / à faire..... — 2e: faite le..... / à faire.....

Transportable: assis / couchè à: courte distance / zone des étapes / interieur

Catèg. speciales: Officier / Allié / Musulman / Indigène / Ennemi

(Opération importante)

.....faite le.....

Soins à donner en cours de route

Règime.....

à sonder

Pansement: faite le.... / à faire le..

Services Destinataires:

A.—Chirurgie générale: *grands blessés ou soins op.*
B.—Chirurgie générale: *petits blessés ou soins non op.*
C.—Chir. spéc. *Maxillo-faciale.*
D.—Chir. spéc. *Urinaire.*
E.—Chir. spéc. *Orthopédie.*
F.—Chir. spéc. *Syst. nerveux.*
G.—Chir. spéc. *Ophthalmologie.*
H.—Chir. spéc. Oto. rhino-lar.
I.—*Prothèse dentaire.*
K.—*Physio* ou *Mécanotherapie.*
L.—*Médecine générale.*
M.—Méd. spéc. *contagiou*
N.—Méd. spéc. *Vénériens*
O.—Méd. spéc. *Aff. cut.*
P.—Méd. spéc. *Psychiat.*
R.—Méd. spéc. *Aff. nerv*
S.—*Hôpital sanitaire.*
T.—*Convalescents.*
Z.—*Eclopés* ou petits malades (zones des étapes)

FIG. 1.—The "Pochette" or French Field Medical Card.

Name .....
Rank .....Unit .....

CAN WALK — SLIGHT
Litter Case — SEVERE
(Strike out words not applicable)

DIAGNOSIS (briefly)

(Special attention needed in transit)

Ambulance Label

Ambulance Train (Motor) No. .....
Date .....Hour .....
Destination .....
Arrival, Date .....Hour .....

Hospital Train Label

Hospital Train No. .....
Date .....Hour .....
Destination .....
Arrival, Date .....Hour .....

NOTE.—To be SECURELY tied on patient's clothing over breast. To contain field medical records, and other papers relative to patient.

FIG. 2.—Face of U. S. Field Envelope.

APPROVED ABBREVIATIONS

Morphia .....M.
Anti-Tetanic Serum .....A.T.S.
Gunshot Wound .....G.S.W.
Fracture, Simple .....F.S.
Fracture, Compound .....F.C.
Fracture, Compound, Comminuted.F.C.C.
Not yet diagnosed or
Undetermined .....N.Y.D
Fever of Unknown Origin .....F.U.O.
Disordered Action of Heart .....D.A.H.
Slight .....O.
Severe .....S.

FIELD MEDICAL CARD

Name .....
(Block letters)
Rank .....No. .....
Regiment or Staff Corps .....Co....

Sick Wounded
Line of Duty—Yes or No
(Strike out descriptions which do not apply)

Field Hosp. No. .... Evac. Hosp. No. ....
Dressing Station No... Camp Hosp. No...
Date of Admission .....
Morphia
Dose and Time
A. T. Serum
Dose and Date
Diagnosis

Base Hospital No. .....
Diagnosis (if altered from above)

Base Hospital No. .....
Diagnosis (if altered from above)

FIG. 3.—Outside of U. S. Army "Field Medical Card" (adopted from the French "Billet d'Hôpital de Coupons") to be folded in three and carried in Field Envelope.

Date of entry and medical unit receiving patient must be recorded immediately on admission and signed by M. O.

Brief Clinical Notes

Field / Evacuation / Camp } Hospital No.... Date of Entry .....
Date of Entry .....

Base Hospital No. ..... Date of Entry .....

Base Hospital No. ..... Date of Entry .....

This card must accompany the patient, attached to his clothing. It must not be destroyed. It will be transmitted with the patient if he is evacuated to the U. S. Temperature charts or additional clinical notes may be sent with this card in the same envelope.

FIG. 4.—Reverse of U. S. Army Field Medical Card.

ABBREVIATIONS OF FRENCH TERMS

A.C.A. = Ambulance Chirurgicale Automobile ("Autochir")
Abs. = Abstention (no operation done)
Bl. = Blessé (wounded)
Debr. = Debridement

E.O. = Eclat d'Obus (shell fragment)
Esq. = Esquillectomie (removal of bone fragments, as distinguished from sequestrotomy, which is removal of sequestra)
Ev. = Evacuer (to evacuate)
Exc. = Excision
Extr. = Extraction
H.O.E. = Hopital d'Evacuation
Nett. = Nettoyage (mechanical cleansing)
O.E. = Orifice d'Entrée (wound of entrance)
O.S. = Orifice de Sortie (wound of exit)
Seton = Superficial perforating wound, not extending beneath deep fascia
T.S. = Train Sanitaire (hospital train)

ABBREVIATIONS OF ENGLISH TERMS, INCLUDING THOSE RECOMMENDED FOR ADOPTION FROM THE FRENCH

Abs. = Abstention, *i.e.*, examined, and no operation deemed advisable
Debr. = Debridement, wide opening of wound to make all parts easily accessible
A.T.S. = Antitetanic serum
Esq. = Esquillectomy, removal of bone fragments
Ev. = Evacuate
Exc. = Excision
Extr. = Extraction
F.S. = Fracture, simple
F.C.C. = Fracture, compound, comminuted
M. = Morphin
Nett. = Nettoyage, mechanical cleansing
O.E. = Orifice of entry
O.S. = Orifice of sortie
S.F. = Shell fragment
Ball = Machine-gun or rifle bullet

TRANSACTIONS
OF THE
PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting held May 5, 1919

Dr. George G. Ross, Acting President, in the Chair

RECOVERY AFTER OPERATION FOR TRAUMATIC LACERATION OF THE LIVER.

Dr. John B. Roberts presented a little girl about seven or eight years old who had rupture of the liver the result of an automobile accident which occurred about the middle of February. The child was sitting on the curb when the automobile struck her on the legs throwing her on her abdomen upon the pavement. She was brought into the Polyclinic Hospital suffering great pain in the upper abdomen. Percussion showed that there was fluid in the abdominal cavity. Upon opening the belly he found a tongue-shaped flap about 2½ inches long and 1½ inches wide had been torn off from the lower surface of the liver near the gall-bladder. The pedicle was posterior. There was blood in the abdominal cavity, the retroperitoneal space and in the layers of the gastrohepatic omentum. By turning the flap up and pressing a thumb upon it, it was held in place and the bleeding was checked. He put against the replaced liver tissue a packing of two yards of bandage 1½ inches wide. This he held in place by an old-fashioned glass drainage tube with its bell-shaped outer end against the packing and brought the end of the tube obliquely through the abdominal wall. The child was in the hospital for about two months and has now been out for two weeks. There will probably be a hernia where the packing was allowed to extend outwards. It was gradually removed in about three weeks. He presented the case because traumatic rupture of the liver with operative recovery is rather unusual. The fortunate result was due to getting the abdomen opened promptly and the torn piece of liver replaced before a large amount of bleeding had occurred. He reported some years ago to the College of Physicians of this city a case in which he lost a patient after traumatic rupture of one of the hepatic veins upon which he had operated.

Dr. George G. Ross said that he had had two cases of rupture of the liver from traumatism. Both were ruptures of the right lobe and both were treated by packing, without attempting to suture. The first case recovered after a stormy convalescence. In the second case after the rent had been successfully packed it was reported that one piece of gauze was missing. In order to account for this it was necessary to search the abdominal cavity and in so doing the gauze which had been packed into

the rent of the liver was displaced and before it could be put back the man bled to death on the table. In rupture of the liver with excessive hemorrhage and shock, a minimum amount of surgery is all that should be attempted. In three cases in which there was rupture of the spleen, instead of taking the spleen out, he used packing, with recovery in all three cases. In a case seen recently the patient was wrestling with another boy weighing 200 pounds who fell across his abdomen, causing a rupture of the spleen. The abdomen was opened by a left rectus incision and the rent in the spleen felt. Packing was inserted and the boy put to bed. He reported four or five months afterward apparently in perfect health.

A CHILD WITH DOUBLE CLEFT OF LIP AND PALATE, PROTRUSION OF THE INTERMAXILLARY PORTION OF THE UPPER JAW AND IMPERFECT DEVELOPMENT OF THE BONES OF THE FOUR EXTREMITIES.

Dr. John B. Roberts showed an infant of Italian parentage, belonging to a family in which there was a good deal of intermarrying. The parents of this child are first cousins. There are two living children, one eleven years; one, three, both girls. The first child, born in Italy, was a monstrosity and is dead. The two next children are normal in development. Three years ago a girl was born almost identical in deformities with this male child shown the Academy. The girl just mentioned died shortly after birth and this boy will probably not survive many days. He is now about a week old. (Note.—The child did die when fifteen days old.)

The X-ray pictures taken show that the femurs were quite well developed, but the bones of the leg proper on both sides are almost absent. The bones of the arm are apparently absent, though both upper extremities have the radius and ulna. The photographs accompanying this report show the peculiarity of the child better than any description that can be given in a short communication. Doctor Roberts expects to deposit the infant in the Mütter Museum. There is now in the Anatomical Laboratory of the Polyclinic Hospital the preserved body of the sister, born three years ago, belonging to Dr. Addinell Hewson's collection. The two children are almost identical in appearance, and the sister died when only a few days old as has previously been reported.

THE METHOD OF RECORDING SURGICAL OPERATIONS AT THE FRONT

Dr. Astley P. C. Ashhurst read a paper with the above title, for which see page 241.

Dr. Thomas F. Mullen, Major U. S. A., of Pocatello, Idaho, said that he had had some experience with French and American records and he was absolutely in accord with what Colonel Ashhurst had said about the

FIG. 1.—Louis M. Case of cleft palate and other congenital deformities of bones.

FIG. 2.—Same patient as Fig. 1, one week old.

completeness and the good appearance of the French cards. The American cards are usually written in pencil which is apt to be rubbed off and the cardboard breaks easily. It is interesting to hear what happens to the cards after reaching Washington, because in the midst of their work they received a general order that the surgeon in charge of the service must personally see that all field cards were kept, giving diagnosis, clinical, operative and final notes. Before leaving Paris an attempt to do that was made. Colonel Hutchins made very complete records, at his own expense in employing stenographers. In some instances he detailed their own clerks, but the records made in the operating room by the anæsthetist or assistant operator necessarily often proved unsatisfactory. The French record card was very good because it needed only a check or underscoring of one of the printed forms accompanying it. Usually they were enclosed in their envelopes and not apt to get lost. Often the American cards did not belong to the soldier of whose case they were supposed to be a record.

Dr. Charles F. Mitchell said that the British field card is a much smaller card than the French with four sides and is pretty much the same as Doctor Ashhurst described. It gives the name of the patient, when he was injured and other data, and is very satisfactory in every way. If an X-ray had been taken at the field ambulance or casualty clearing station all the data were on the card. If a case remained for some time at the field hospital some extra temperature charts accompanied the card. It seemed to him a great advantage to have everything on one card rather than to have a lot of papers with the card. It was a simple matter to make these memoranda and while working at the casualty clearing station Doctor Packard was with him, and while sewing up a wound he would take the notes dictated to him. He never felt that they needed a clerk. As a matter of fact, their quarters were so small that they would not have had room for more people. The English card is really the ideal one.

Dr. Edward B. Hodge said that he felt a good deal as did Doctor Mitchell. The French card looks like a good one, but he would prefer the British. An advantage of the British card was that it did not have loose slips of paper which could be easily lost. He never worked with the French but he could appreciate their thoroughness. Most of the trouble, in his opinion, was due to inexperience of operating teams. The British card is complete and thorough and, when well worked, went through in good style. All that was needed was there and, like everything else, when properly worked, gave good results.

Dr. George G. Ross asked Doctor Ashhurst whether he had seen the German field record card, which is made of material something like linen paper and is difficult to tear and has a series of perforations by which certain portions of the edges can be detached. There were five or six different headings, giving time of injury, character of wound, when first

aid treatment was given and whether operation had been performed. For simplicity and general outline of what had been done the card seemed to him nearer the ideal than any other seen. He happened to get one from a wounded German who was brought into the field hospital where he was working. Probably Doctor Ashhurst's approval of the French card may be due to the fact that he was able to read, talk and live French, which many others could not do. He asked whether about the time of the 18th and 19th of July at Soissons, when the men were coming back by the hundreds and the surgeons were working from twelve to thirty-six hours, they could be held morally responsible for not keeping accurate records.

At Field Hospital No. 12 there were three teams to start with, later increased to seven. There were three tables and one scribe to take all the notes dictated by the surgeons and the assistants. During six days 3500 patients passed through this unit. The notes were taken with pencil in bad handwriting and no doubt worse English. Copies were made of the data so that after all most of the material was preserved. In certain times of stress it was not possible to do this.

BOOK REVIEW

SURGICAL TREATMENT. A Practical Treatise on the Therapy of Surgical Diseases for the Use of Practitioners and Students of Surgery. By JAMES PETER WARBASSE, M.D. In three large octavo volumes. Volume III, 861 pages with 864 illustrations. Philadelphia and London. W. B. Saunders Company. 1919.

The first two volumes of this book of Warbasse have already received review (see ANNALS OF SURGERY, lxviii, 446, and lxix, 222). The present volume completes the treatise. It is supplemented by a complete index to the three volumes in a separate convenient volume of 123 pages. Such an index to so comprehensive and extensive a work is of as great importance to the practical usableness of a book as a knob is to a door. It opens the book for ready reference. To have the general index furnished to us, as Doctor Warbasse has done, as a separate book, easily handled and readily referred to, is a most commendable and attractive novelty in book-making.

The preparation of such a comprehensive treatise by a single author is an unusual achievement in these days of coöperative authorship, and of the production of systems which are a series of monographs by many authors.

It is altogether more noticeable and interesting since the author has been conspicuously an advocate of the coöperative principle in other forms of human activity. He has certainly presented a strong demonstration of the fallacy of his own reasoning in other fields in the excellence and value of these three great volumes, produced by his single authorship, in which he has embodied the results of his own studies and labors through thirty years of devotion to surgery, for they are the more valuable as they have running through every chapter the same restraining, guiding, conservative, experienced, judicious mind.

We are glad Doctor Warbasse has given us this book. As we have it we feel as if we could always appeal to "Philip sober" whenever we find that its author, branching out into other fields, is betrayed into fallacies, possibly mischievous; in this book we have the "swan song" of the author as a surgeon; it is a thesis with which he has bidden farewell to surgery, henceforth to devote his time and energies to other lines of effort. It seems a pity that this should be so, but it is doubtless the result of the application to his own life of those principles of surgical economics which he has presented in the closing pages of this treatise. According as we have been able to gather the drift of the author's reasoning, he would have it that "individualism" is the bane of surgical life, as well as of the social state in general. Truly a revolution-

ary doctrine in this Western Hemisphere, where all the philosophy of its civilization and of its development to this day has had as its basis the proclamation of the rights of man as an individual to life, liberty, and the pursuit of happiness!

However this may be we are sorry to lose from the list of practical surgeons the author of so notable a work as these three noble volumes. It is to be regretted that at the time when by his age, his undiminished vigor, his accumulated experience, and ripeness of judgment he could have filled in the world an important and most useful place in this special field, in which he had shown such aptitude and demonstrated such skill, he should have abandoned a field in which this book shows him to have become a master. In this last volume the field of surgery is swept up to gather in the subjects remaining from the two first volumes, beginning with Hernia and ending with "The Economics of Surgical Treatment," and including The Surgery of the Extremities, that of the Genito-Urinary Organs, male and female, and Plastic Surgery. This volume preserves the same characteristics as were noted in the earlier ones: clearness of treatment, positiveness of statement, vigorous diction. The work, as a whole, may be accepted as a faithful mirror and a trustworthy guide in the field of surgical treatment as developed to date.

LEWIS S. PILCHER.

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